

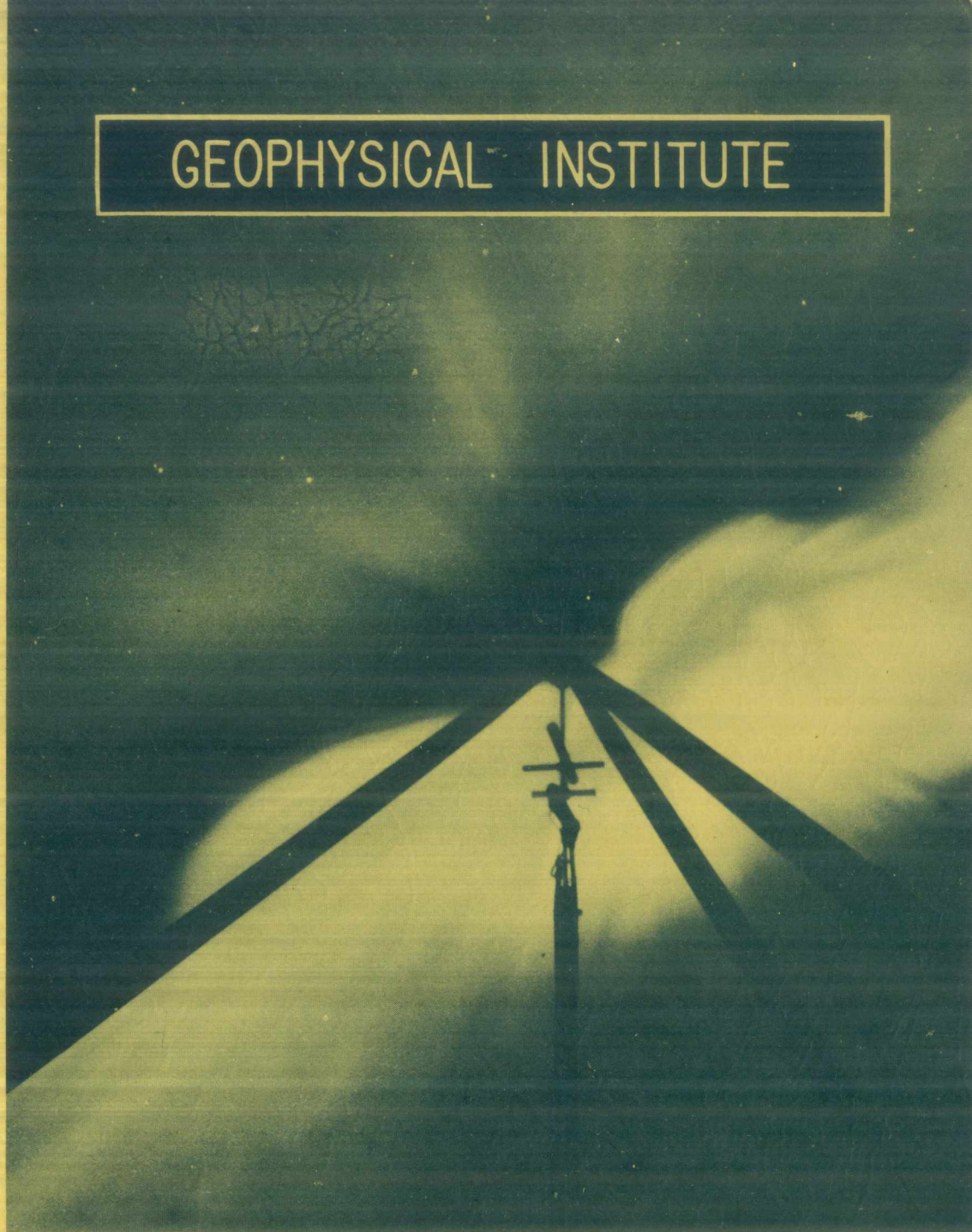
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GEOPHYSICAL INSTITUTE

UNIVERSITY
OF ALASKA

COLLEGE
ALASKA

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Earth Current Activity at College, Alaska, July 1959

by

V. P. Hessler

Scientific Report No. 4

Contract No. AF 19(604)-3075

June 15, 1960

Geophysics Research Directorate
Air Force Cambridge Research Center

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Air Research and Development Command
United States Air Force
Bedford, Massachusetts

Report approved by:


C. T. Elvey, Director

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ABSTRACT

This report presents College N-S earth current records for the month of July 1959. The scale of 1 inch per hour permits detailed scaling directly from the reproductions in the report. Scalings of hourly range in amplitude and rapid fluctuation activity are given. The amplitude scalings are also presented as curves together with average curves for a period of several years to show the relative magnitudes of the July 1959 activity. The earth current always displays much more pronounced fine structure than the corresponding geomagnetic activity.

Introduction

This report presents the College earth current traces for the month of July 1959. This month was selected for complete reproduction of the traces because of the several major solar-induced terrestrial events which occurred, and because of the extensive interdisciplinary analysis which is to be made of these events. A great solar flare occurred on July 16. In conjunction with this flare the College Magnetic Observatory reported four 9's among their K indices. During the same period the College earth current recorders were far off scale. The ionospheric absorption of 27.6 mc/s cosmic noise was abnormally high during most of the period from the 10th through the 20th, and there were unusual cosmic ray events on the 17th and 18th.

The traces are presented to a scale of 1 in/hr to permit detailed scaling directly from the reproductions in the report.

Experimental

The earth current electrode field is located a few hundred feet to the west of the Geophysical Institute building on the University of Alaska campus at College. The College geographic coordinates are $64^{\circ} 51' N$ and $147^{\circ} 50' W$ and the geomagnetic coordinates are $64^{\circ} 37' N$ and $256^{\circ} 30' E$. The N-S electrodes are spaced 300 ft. and aligned with the geographic meridian. The electrode pair resistance as measured with alternating current ranges from 125 to 200 ohms during the year. The chemical potential is low and very constant except for slow changes which occur during spring breakup. The location of the electrodes is in a wooded area which is almost entirely free of interference from man-made electric currents.

The records were taken on a Brown Electronik recording potentiometer with a full scale range of 5 mv and a full scale response rate of 4 seconds. An attenuating and centering network adjusts the instrument range to about 1200 mv/km

and inserts sufficient series voltage to center the quiet day trace.

The recorder is equipped with cycle counting equipment which consists of a 10-point stepping relay, a clutch driven microswitch, and an operations pen. The microswitch is closed when the pen drive starts upscale and opens when it starts downscale. Thus, within the sensitivity of the equipment the stepping relay advances one step for each cycle of fluctuation regardless of its amplitude or the position of the pen on the scale, and the operations pen makes one pip for each 10 cycles. At the 1200 mv/km range the counting equipment is sensitive to earth current variations with a range of 5 mv/km at any part of the scale.

Scaling

The earth current traces were scaled for hourly values of arithmetic range in a manner similar to that used in scaling magnetic K-indices. By range is meant the difference between the greatest positive and negative departure from an arbitrarily assigned zero trace (the diurnal variation at College is negligible in comparison with the disturbance phenomena). These results are tabulated in Table I. "Greater than" indicates off scale at one side of the chart and "much greater than" at both sides.

The rapid fluctuation record is scaled by counting the number of downward pips of the operations pen for each hour and multiplying by 10. These results are tabulated in Table II.

Discussion

It has long been observed that earth current hodograms, both for diurnal variation and for individual disturbances, tend to follow a principal direction. At observatories located near the sea the direction is generally perpendicular to the shoreline. X-Y plots of the earth currents at the College Institute site for periods of about 24 hours develop into more or less completely filled in

highly eccentric ellipses with the major axis about 33° west of north. For additional discussion concerning the directional effect refer to Burbank (1905), Fleming (1949), Hessler & Wescott (1959b), Wescott and Hessler (1960), Rooney and Sherman (1934), Rooney (1949) and Yoshimatsu (1957). Because of the pronounced directional effect there is little to be gained for most purposes in presenting both the N-S and E-W traces. Thus only the N-S traces are presented in this report.

The amplitude of any particular fluctuation can be determined to a close approximation by dividing the N-S scaled value by $\cos 33^{\circ}$. However, correction is not particularly useful because of the large variation which occurs from one site to another within an area of a few miles radius (Wescott & Hessler 1960). The records presented herein are for the College Institute site at which the geological and topographical effects produce a telluric electric field intensity about 50% greater than the norm for the area within a radius of 5 miles. The form, relative magnitude and time of occurrence of earth current disturbances are closely related to other ionospheric phenomena, but the actual values as measured in mw/km should be related only on some empirical basis.

There is a very high correlation between earth current and magnetic activity (Elena 1958), (Hessler and Wescott 1959 a and b, 1960). Monthly correlation coefficients between daily magnetic A figures and daily averages of the 3-hour earth current scalings are in the range of .95. Thus the earth current scalings may be used interchangeably with A figures or with the K-indices as an indicator of ionospheric activity.

The College earth current traces generally tend to display more fine structure than the corresponding magnetic records as noted in Figure 1. The magnetic H-component was recorded on an Esterline-Angus recorder with a National Union magnetic pickup tube serving as the sensing element. The response rate

of the earth current and magnetic recording systems was identical. It has also been noted that the amplitude of the rapid fluctuations at Barrow is always much less than at College. Thus we conclude that the College earth current records display an aspect of ionospheric activity not evident in the magnetic records, but that this may not be true of observatories at other geomagnetic latitudes.

The relative magnitude of the July 1959 average activity is illustrated in Figure 2. If it is desired to compare the July 1959 events in more detail with other earth current events, see Hessler and Wescott (1960) and "High Latitude Geophysical Data". Complete earth current scalings from January 1956 to date are given in these publications.

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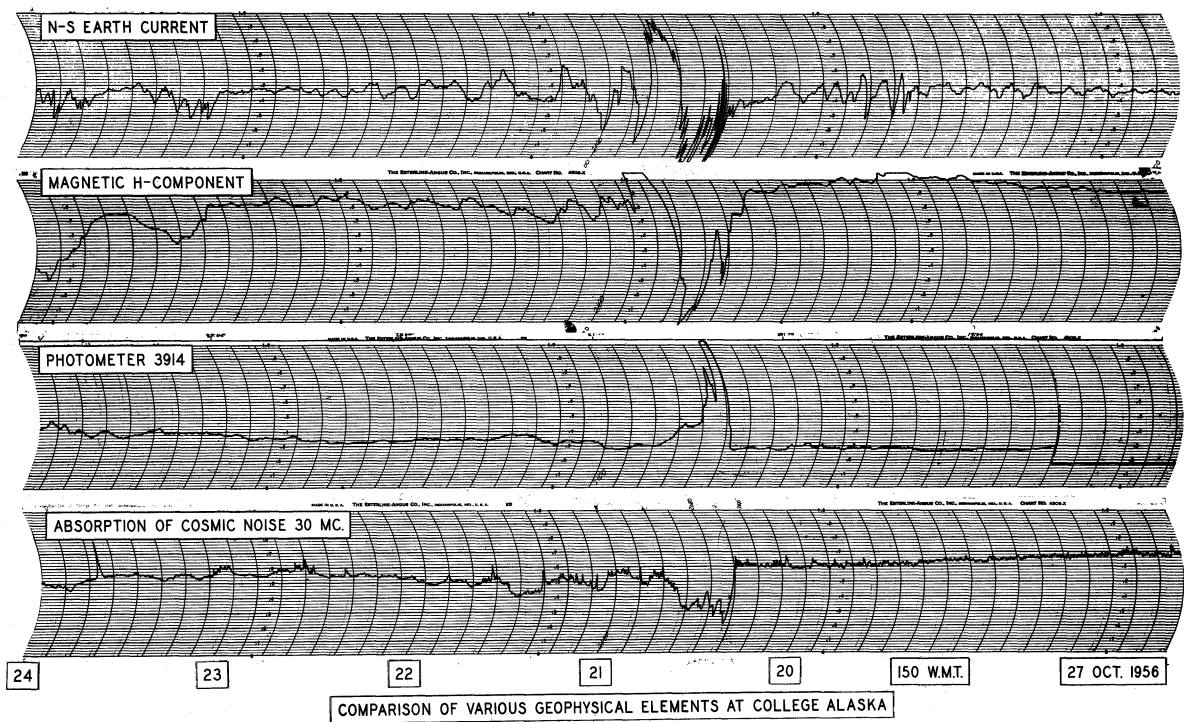
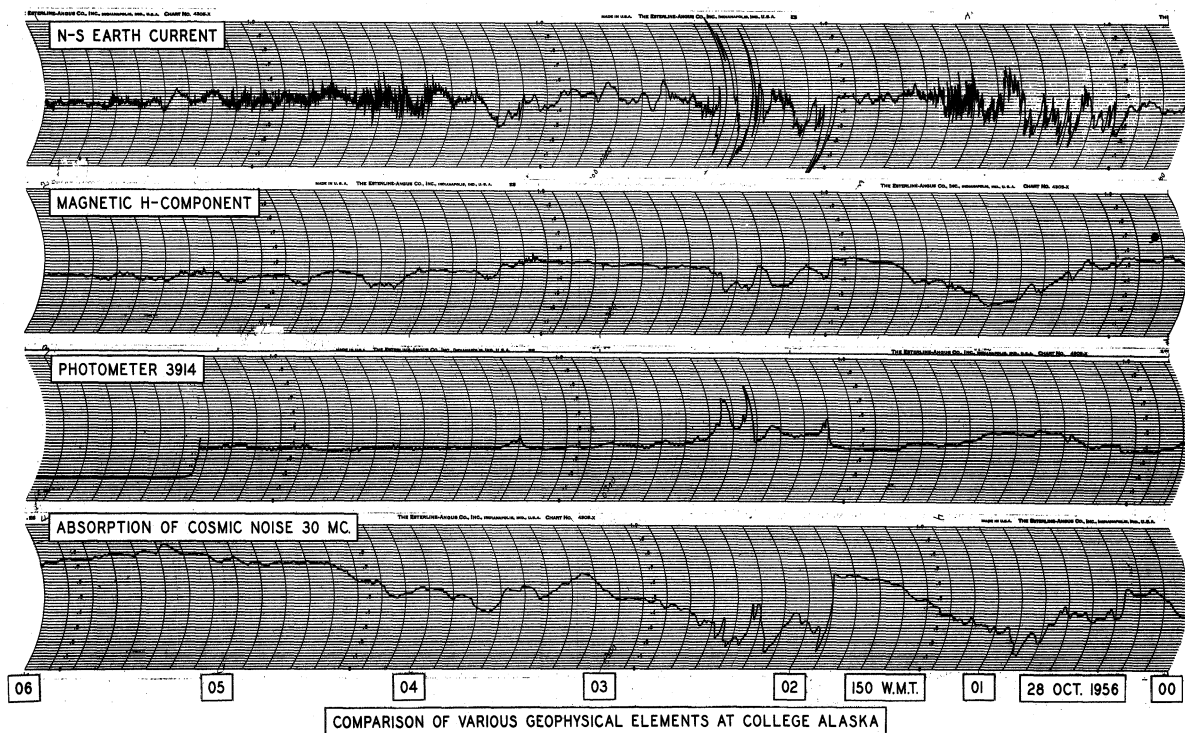


Fig. 1. Comparison of various Geophysical Elements at College, Alaska.

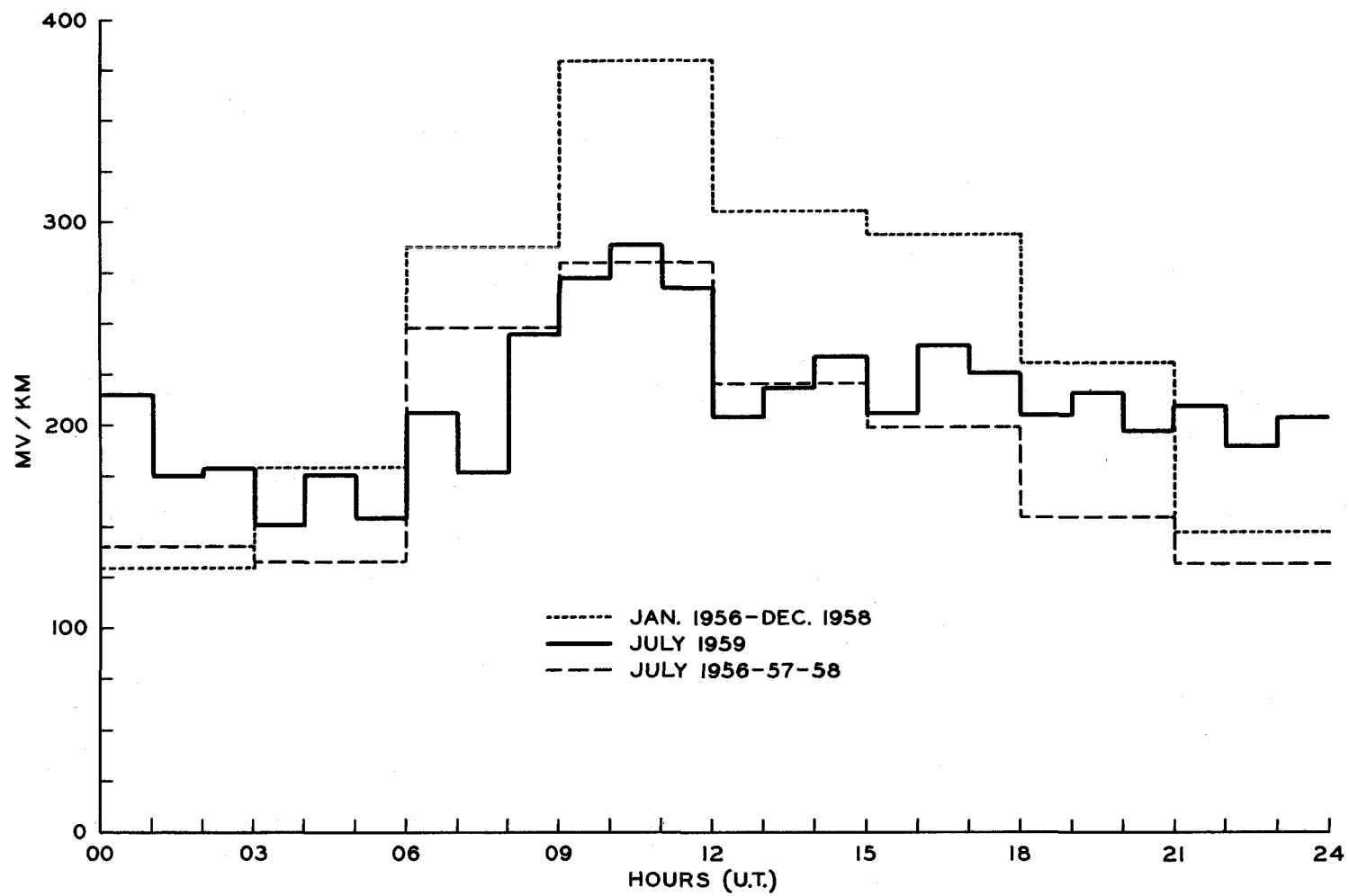


Fig. 2. Earth Current Activity at College, Alaska.

Table 1

N-S Geoelectric Activity -- mv/km

Month: July 1959											Hour (Universal Time)														
Day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Avg
1	90	67	79	79	45	56	23	90	56	34	34	56	23	11	67	23	34	34	45	34	45	56	67	79	51
2	67	90	101	112	382	169	>1090	270	507	236	101	>755	169	79	-	225	270	56	45	34	45	34	34	23	212
3	45	34	56	34	23	23	23	56	11	11	23	23	11	34	45	56	34	34	56	34	23	23	23	23	32
4	22	22	22	11	22	11	22	22	33	99	308	495	110	66	44	209	671	165	143	143	132	110	143	143	132
5	100	132	78	132	264	165	176	198	220	110	264	165	132	319	209	121	88	66	77	132	99	198	77	99	151
6	44	66	55	55	55	44	55	55	121	198	132	187	308	176	231	154	55	77	99	99	176	88	77	110	113
7	66	88	110	55	55	55	22	55	231	319	231	198	154	264	495	352	143	143	99	66	55	66	66	55	144
8	66	66	88	66	99	55	44	66	462	220	231	330	110	220	275	154	55	154	121	66	77	99	110	99	139
9	77	66	66	77	66	121	>902	264	77	231	99	77	550	231	110	44	77	242	110	99	66	66	44	-	164
10	154	77	143	99	143	66	231	165	99	110	44	44	33	22	22	33	33	44	66	66	55	77	99	110	85
11	121	132	110	88	121	165	154	88	77	77	55	88	264	308	198	66	>957	616	330	275	264	330	231	385	229
12	440	264	165	110	154	209	143	121	55	55	121	242	132	330	176	154	187	110	77	66	66	77	88	132	153
13	121	88	77	66	88	44	55	198	132	44	44	77	176	176	242	143	187	55	77	44	66	66	110	66	102
14	99	99	88	165	165	121	99	154	363	198	462	319	330	341	275	198	99	99	77	66	55	99	66	77	171
15	143	99	286	209	176	154	165	253	>1067	>1034	>858	803	>1012	>913	>1067	869	>1067	>1067	>1067	>1067	>1067	>1067	>1067	>1067	735
16	>1067	451	374	484	198	187	330	242	341	242	330	154	176	198	286	165	132	176	187	220	121	88	165	275	274
17	165	143	154	88	275	110	297	66	110	>715	352	341	506	561	352	297	>1067	>1067	>1067	>1067	>1067	>1067	>1067	>1067	544
18	>1067	>1067	>1067	>1067	>1067	>1034	550	660	>1067	517	242	737	220	187	308	1023	473	495	209	385	242	231	385	297	610
19	363	297	506	187	671	264	396	352	341	154	528	385	187	407	385	286	396	286	209	176	231	154	176	154	312
20	209	165	110	66	88	66	88	99	517	374	473	341	143	121	99	99	132	374	231	132	88	165	154	165	187
21	132	154	220	165	77	88	121	143	55	66	110	187	187	88	231	198	121	99	77	143	209	110	132	154	136
22	209	132	121	88	88	77	231	110	55	77	132	132	66	77	297	231	132	154	66	154	154	110	121	121	130
23	187	209	143	44	132	165	187	110	55	165	231	88	44	33	33	33	33	33	44	33	77	99	44	66	95
24	55	66	33	66	44	77	44	55	154	495	550	231	121	165	198	275	253	374	286	264	341	429	308	297	216
25	297	187	176	154	352	594	132	110	286	>847	231	88	308	231	429	297	143	253	605	374	242	429	187	165	296
26	165	319	231	385	132	99	286	396	616	209	627	352	242	242	319	275	187	341	319	869	539	506	220	319	341
27	726	528	429	154	209	253	154	>847	231	>847	1001	341	132	209	143	132	143	187	187	231	176	264	198	209	330
28	187	132	132	187	55	110	99	88	55	88	176	352	176	275	242	143	88	77	143	132	77	132	110	176	143
29	110	110	297	66	66	121	187	44	44	132	231	286	143	33	33	33	66	44	55	44	88	55	44	77	100
30	55	66	44	33	33	22	22	33	11	44	22	121	22	22	22	33	33	33	33	33	33	33	88	22	38
31	22	33	44	77	132	55	88	121	121	484	671	275	110	429	165	88	44	66	154	121	143	154	198	66	161
Avg	215	176	181	151	177	154	207	178	244	272	288	267	204	219	233	206	239	226	205	216	197	209	191	203	210

Selected Days: 5 quiet 1, 3, 10, 23, 30

5 disturbed 15, 17, 18, 26, 27

TABLE 2.
EARTH CURRENT - RAPID FLUCTUATIONS
Cycles per Hour

Month: July 1959

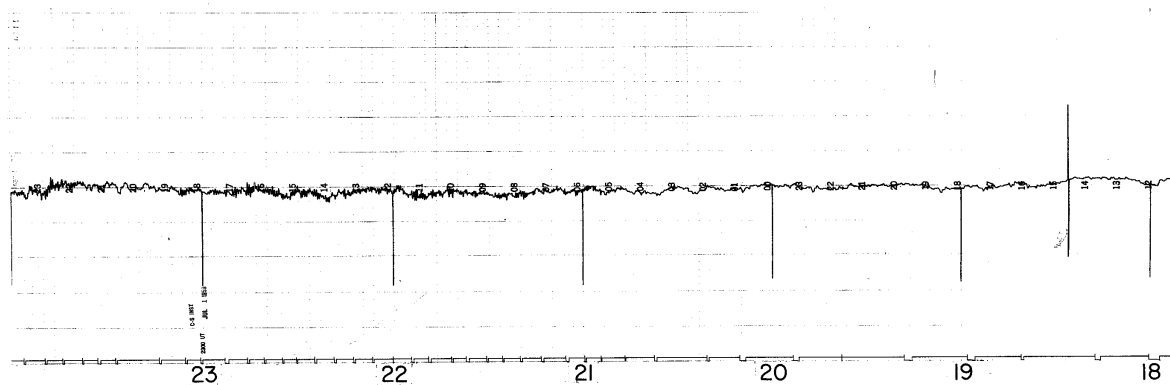
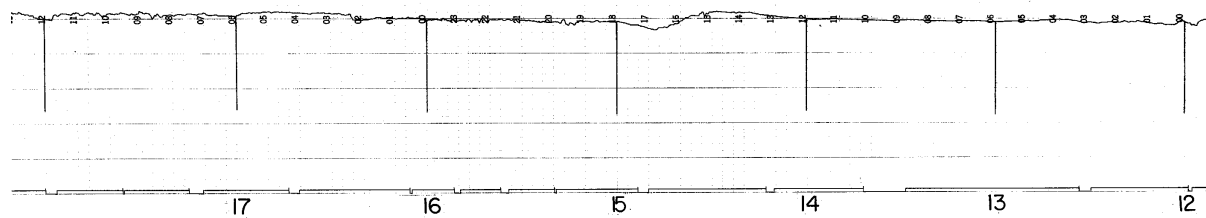
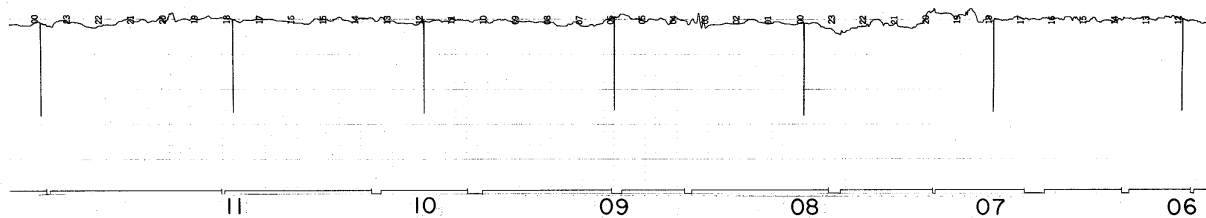
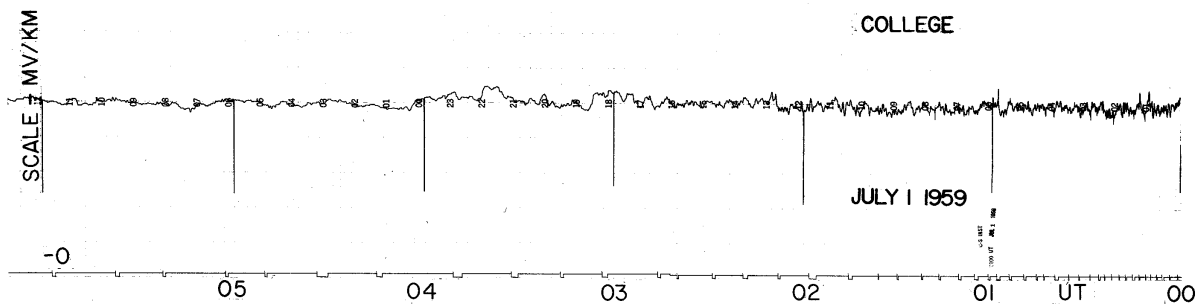
Observatory: College

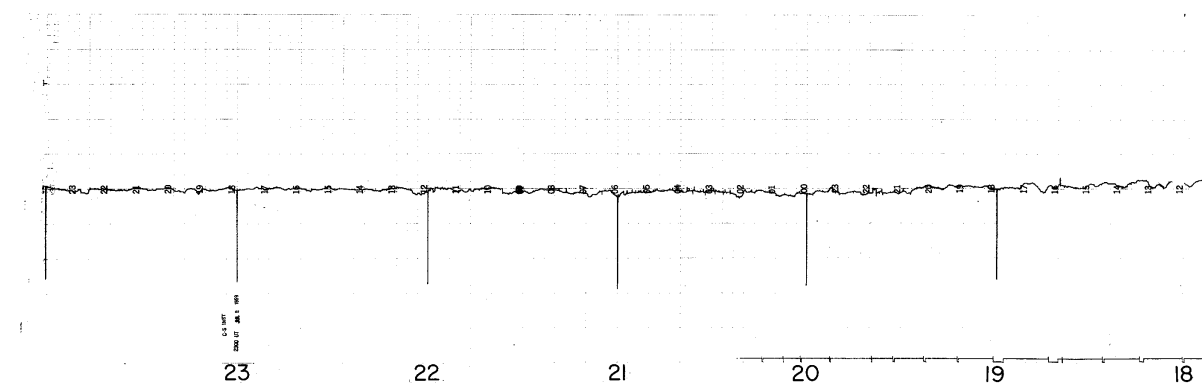
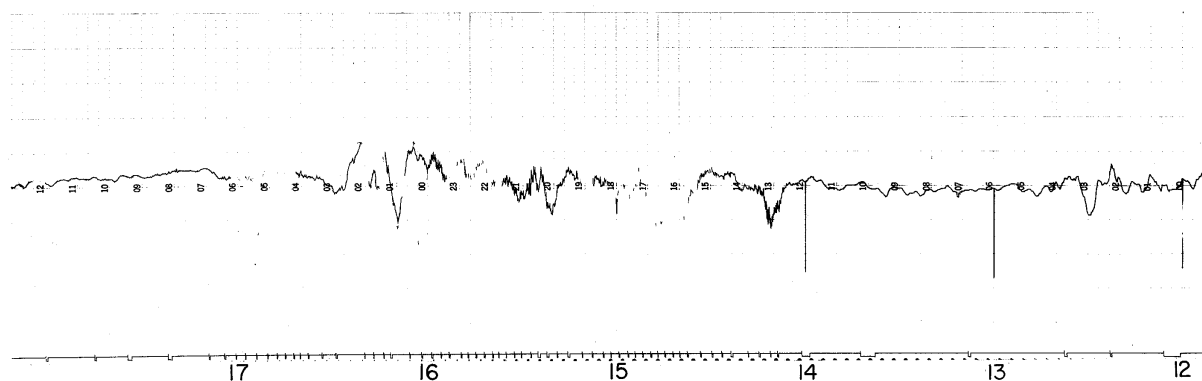
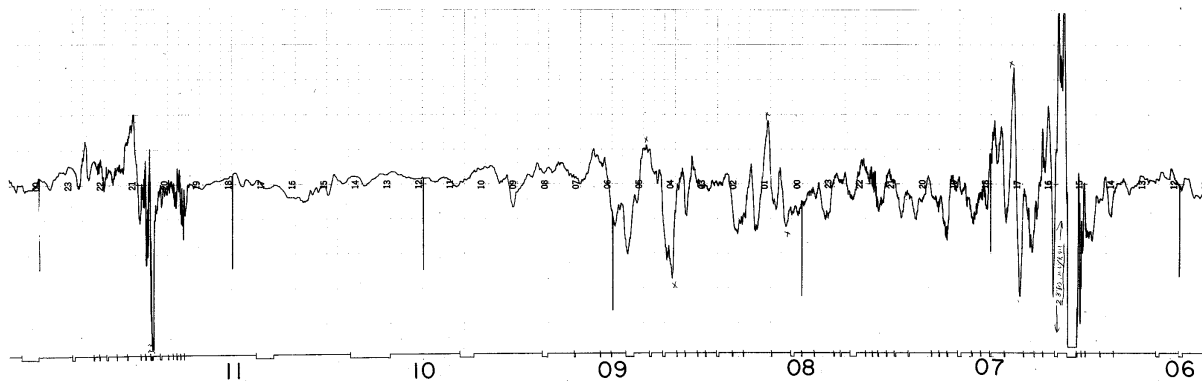
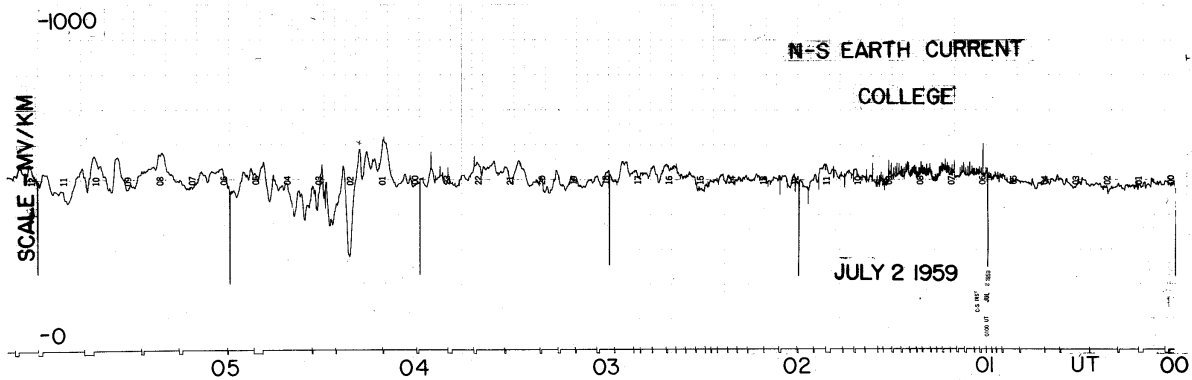
Day	Hour (Universal Time)																							
	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	220	90	50	40	30	40	20	20	20	10	10	20	10	10	20	30	20	30	30	30	60	90	100	90
2	110	200	170	70	50	50	120	180	120	50	20	160	30	30	180	210	150	70	50	50	-	-	-	-
3	-	-	-	30	30	10	20	10	10	0	10	10	0	10	10	10	10	20	30	20	20	10	20	20
4	40	10	30	30	30	10	20	10	10	60	120	220	150	150	50	80	190	130	120	80	180	120	100	100
5	90	60	50	60	60	80	100	50	40	40	130	70	40	210	130	80	60	100	100	100	110	110	80	110
6	80	40	60	60	50	20	40	10	80	60	30	30	120	170	160	150	80	70	90	70	80	100	150	120
7	50	50	50	60	20	30	20	20	120	100	250	80	80	210	190	240	130	110	90	100	90	110	70	80
8	-	80	60	50	40	50	60	20	80	50	120	170	140	210	220	220	80	60	110	90	60	80	90	100
9	70	90	70	30	30	30	110	70	30	50	20	30	230	160	100	30	70	180	110	80	40	50	40	40
10	50	30	40	30	40	20	70	30	30	20	20	20	10	20	20	0	10	20	40	50	80	90	90	80
11	90	60	40	40	30	40	30	30	30	20	20	40	110	220	240	130	160	310	230	170	310	250	200	280
12	220	140	90	50	60	20	30	10	30	20	90	120	120	190	170	100	120	110	70	80	70	90	100	90
13	70	70	50	50	50	40	30	30	20	30	10	30	100	160	240	260	210	70	90	50	60	90	80	50
14	70	60	50	30	30	30	30	20	70	60	170	110	160	330	310	160	80	70	100	90	90	70	100	100
15	60	70	40	70	30	30	10	20	230	180	200	240	180	240	220	240	240	210	240	200	210	200	260	110
16	90	40	30	30	30	40	20	50	80	140	140	150	80	100	280	190	110	130	90	90	80	60	90	110
17	120	110	50	50	30	40	60	50	70	110	140	70	160	220	240	170	>230	>140	>140	>190	>150	>140	>170	>170
18	> 50	>60	>120	>230	>220	>170	60	130	>180	140	40	>150	80	130	90	120	120	80	120	220	170	110	230	160
19	120	100	80	50	40	40	40	60	40	40	90	110	80	250	260	290	280	120	100	90	90	90	110	90
20	50	70	80	30	50	40	30	80	140	110	100	210	100	50	30	50	70	110	110	100	70	130	150	110
21	130	140	80	80	50	40	60	30	30	30	70	140	60	70	180	150	60	80	60	90	80	100	120	160
22	130	130	70	70	60	50	50	30	20	30	30	30	30	60	230	290	210	70	100	90	100	110	160	110
23	70	80	80	30	30	30	90	140	30	50	60	30	20	20	20	10	10	30	30	40	70	130	190	120
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25	100	90	70	50	60	50	80	60	70	190	160	30	100	90	210	130	70	120	210	240	200	150	200	140
26	180	110	140	120	100	90	70	90	160	110	170	140	>70	>160	>120	180	150	>180	>150	>110	180	180	130	160
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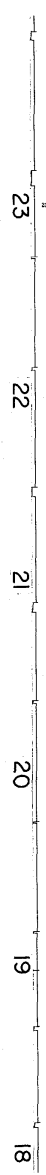
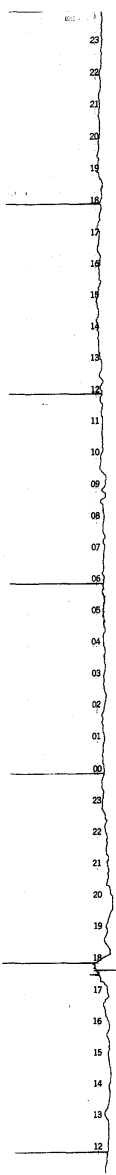
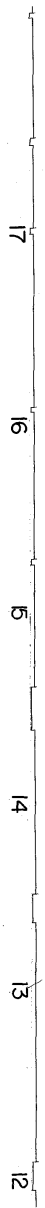
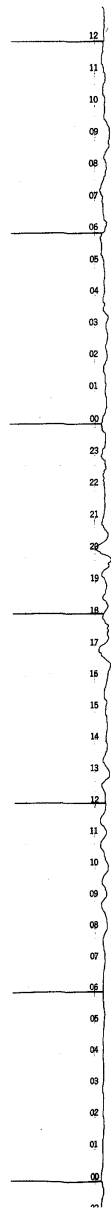
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N-S EARTH CURRENT

COLLEGE







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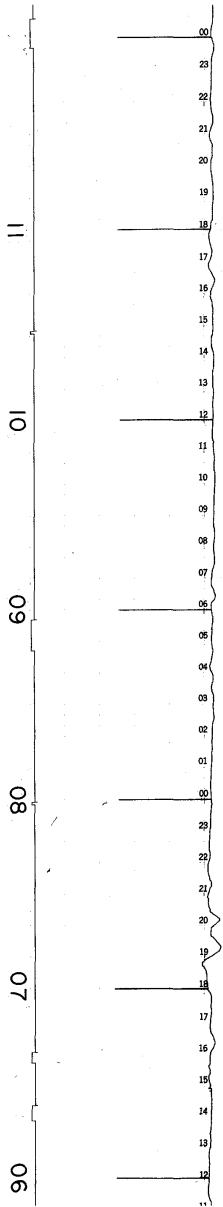
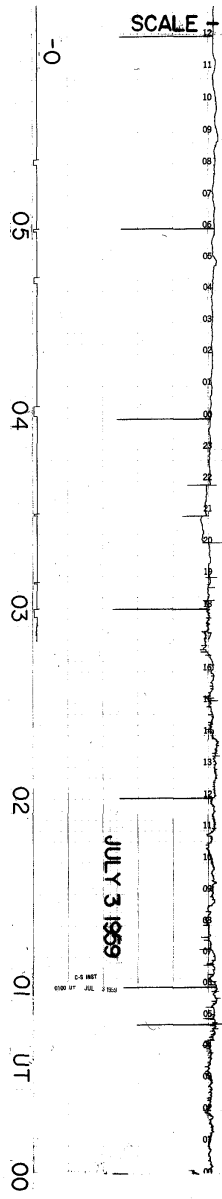
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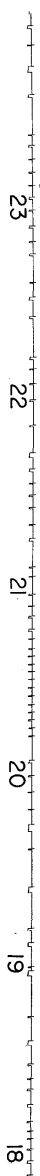
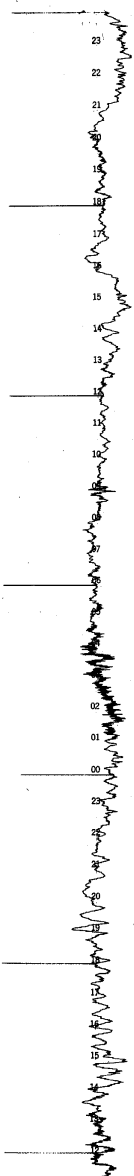
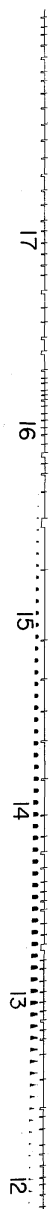
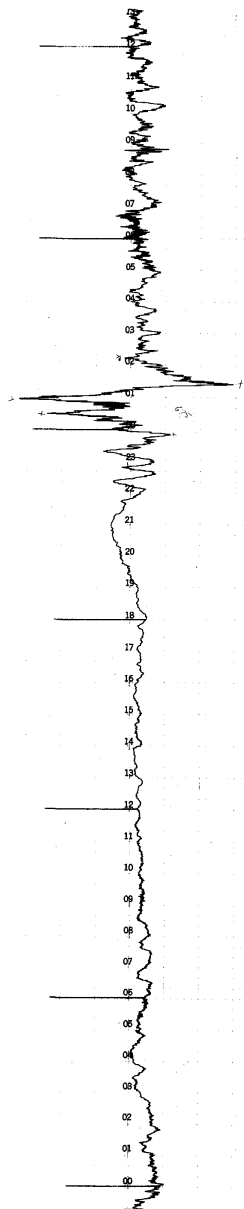
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SCALE - MV/KM

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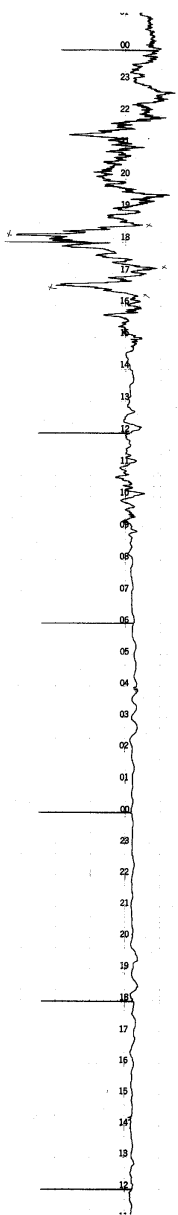
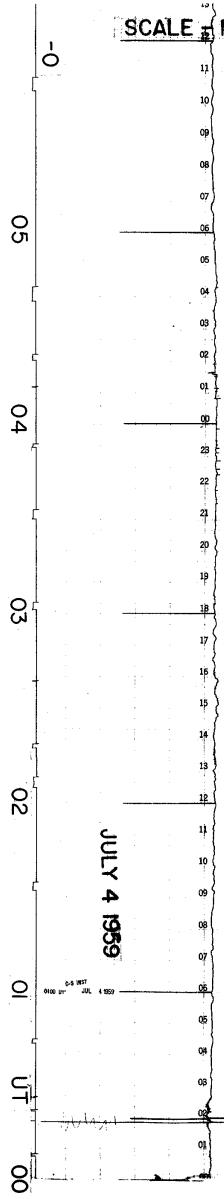
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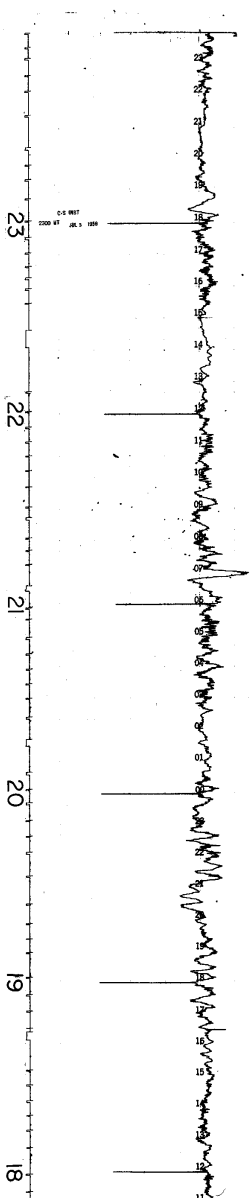
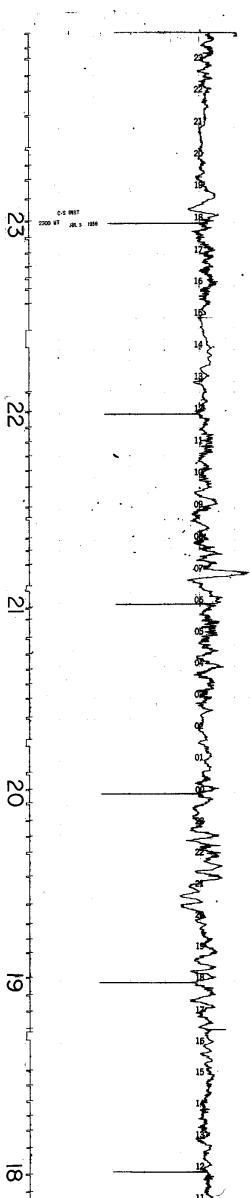
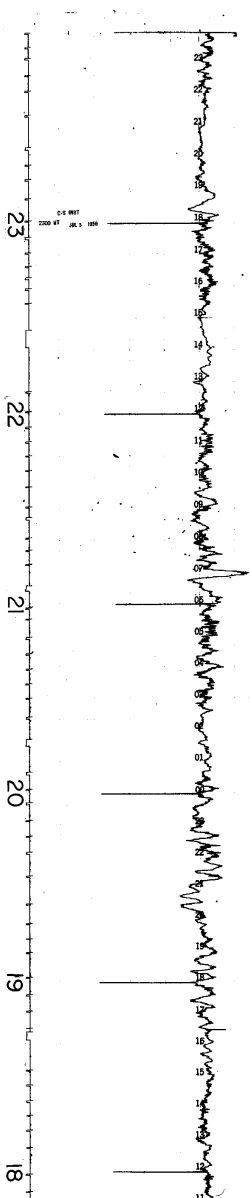
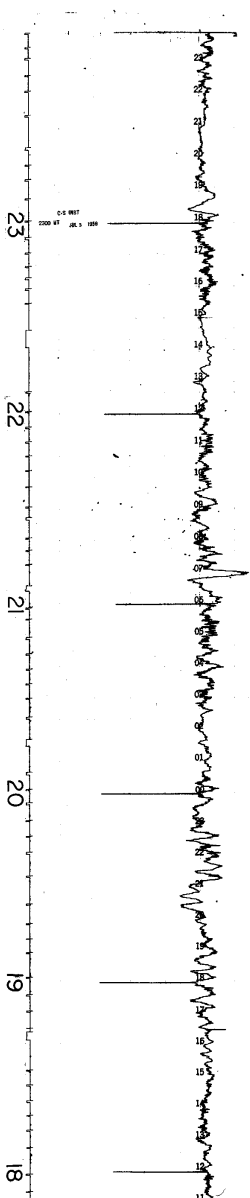
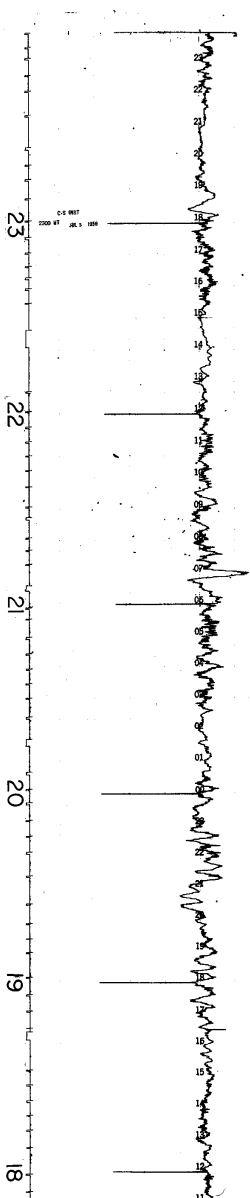
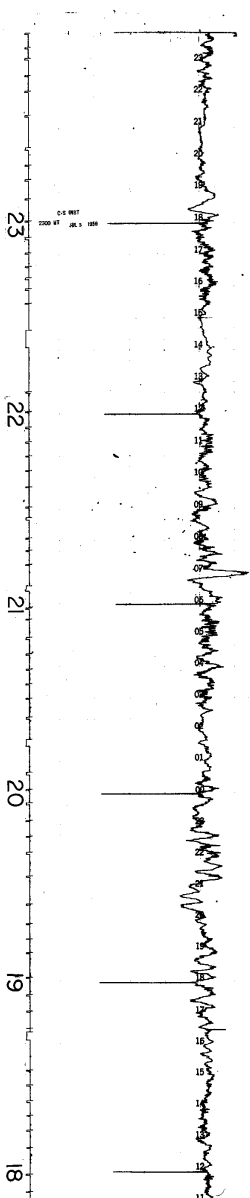
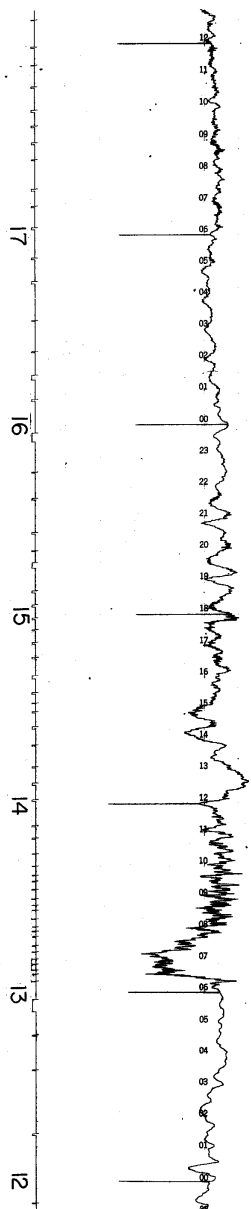
COLLEGE

SCALE 1 MV/KM

JULY 4 1959

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JUL 4 1959



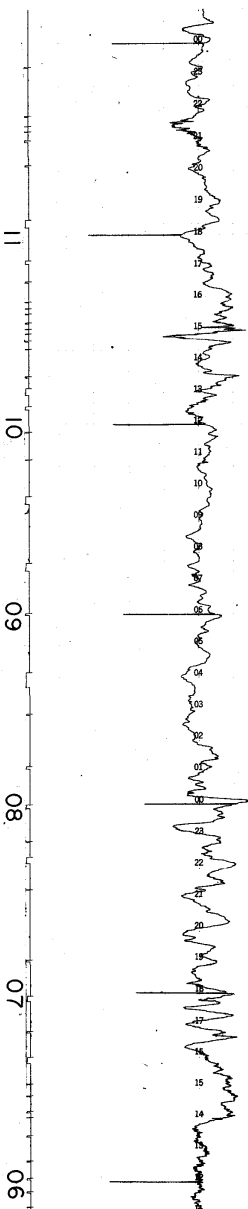
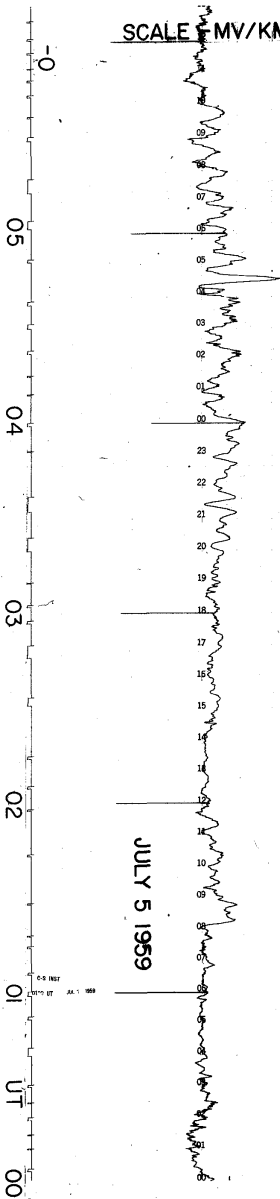


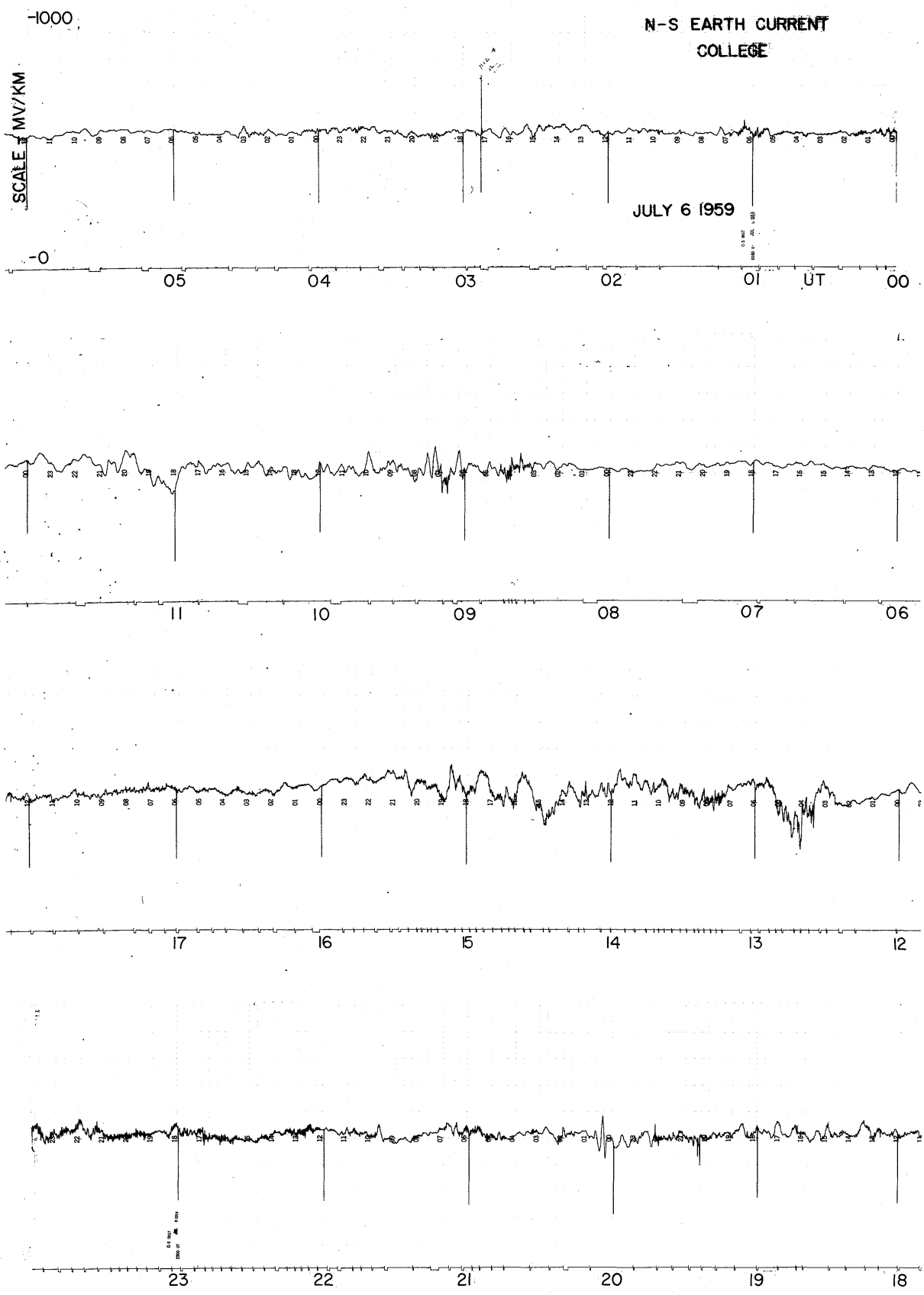
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**N-S EARTH CURRENT
COLLEGE**

SCALE MV/KM

JULY 5 1959





-1000

N-S EARTH CURRENT
COLLEGE

SCALE 1 MV/KM

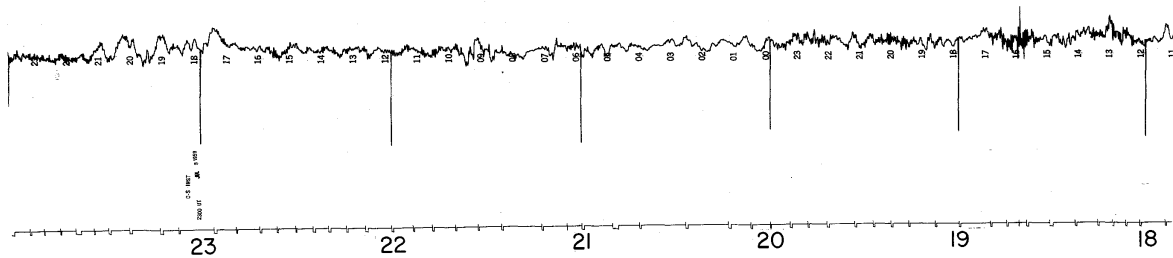
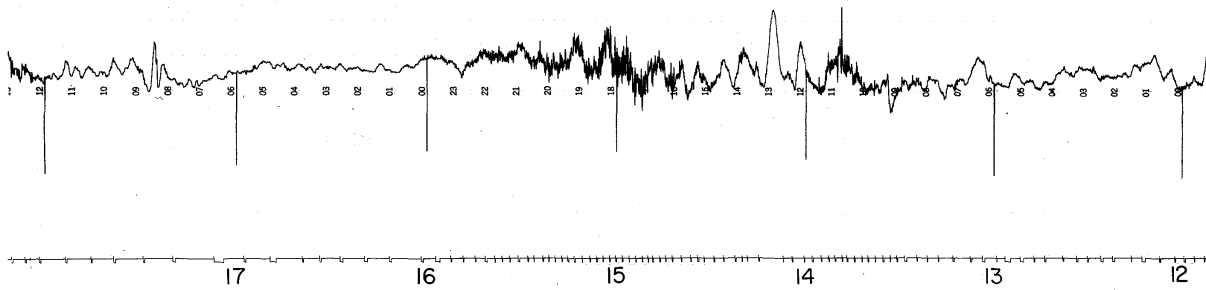
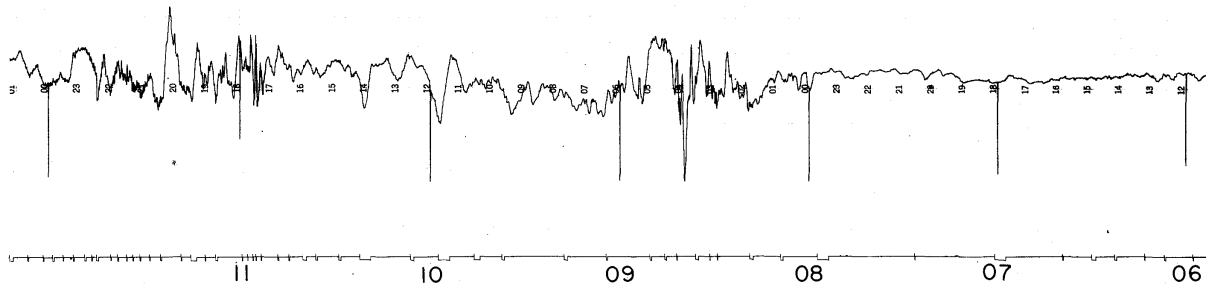
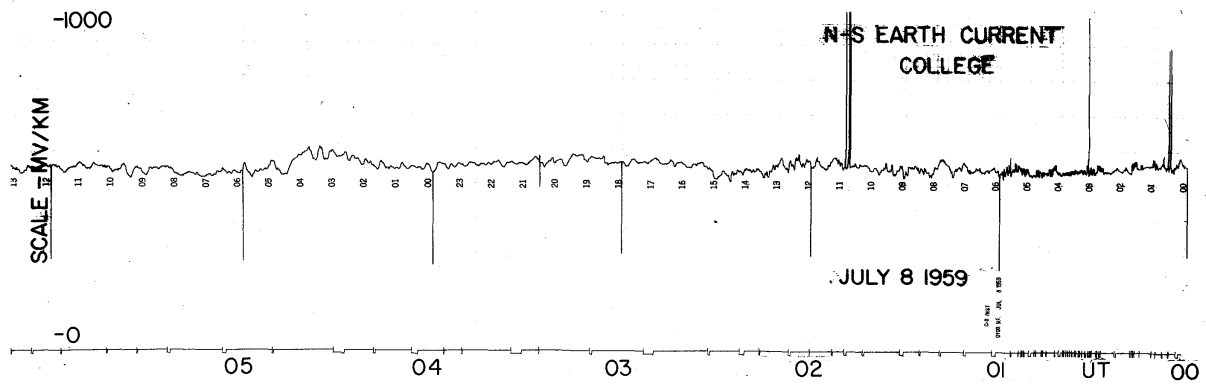
JULY 7 1959

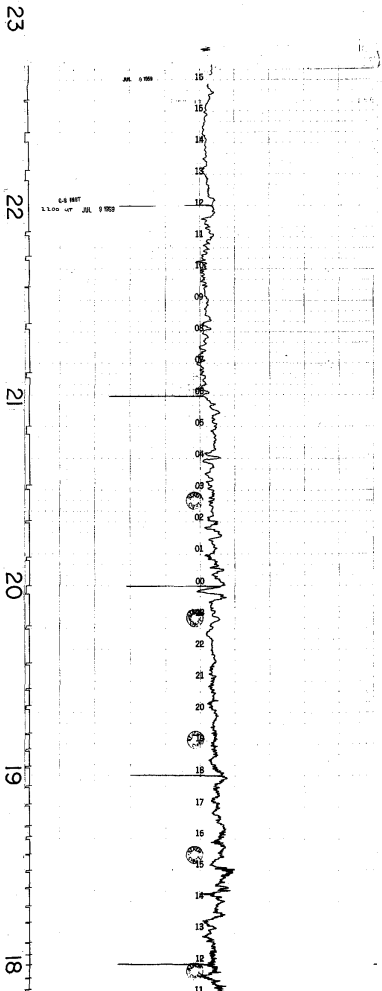
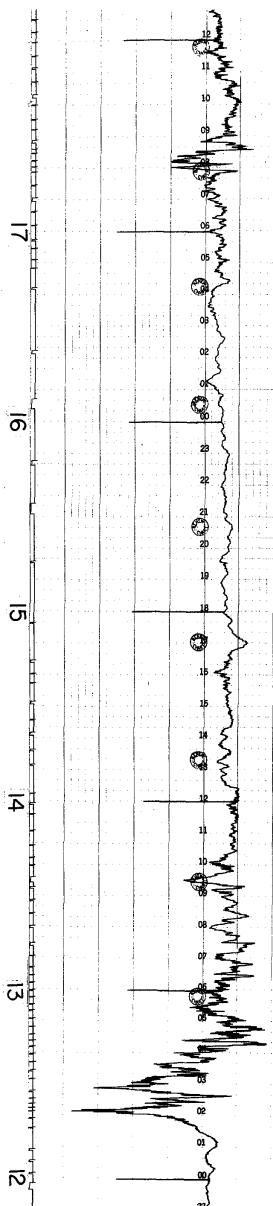
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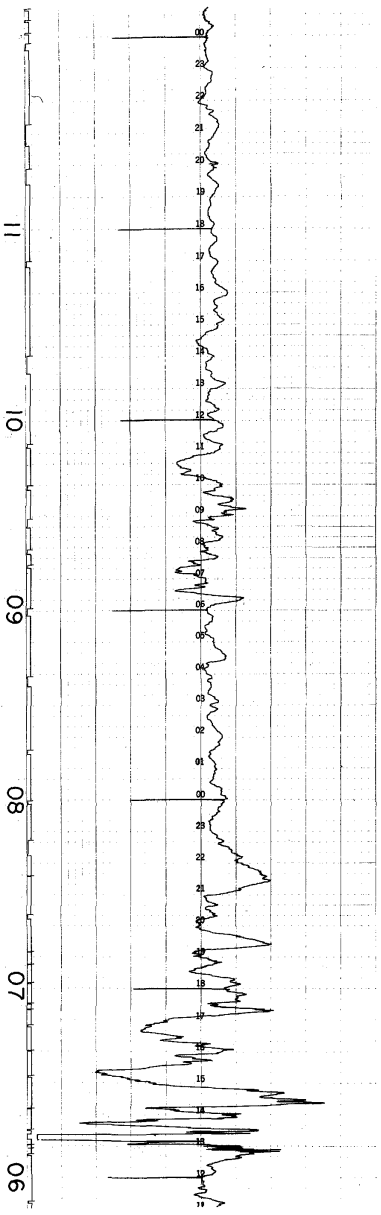
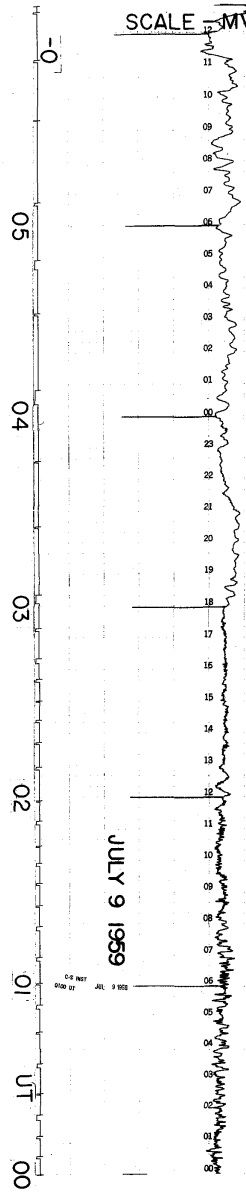


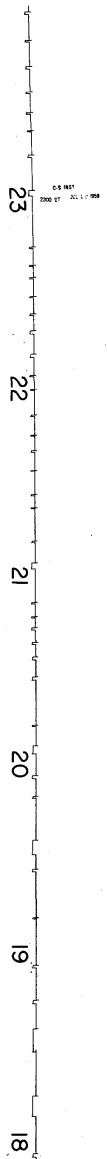
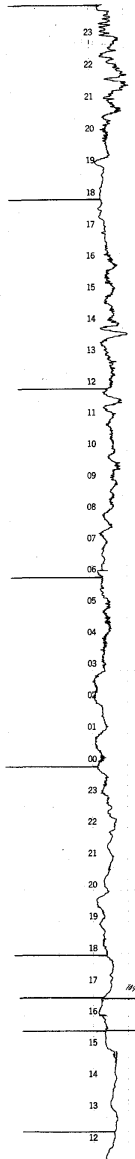
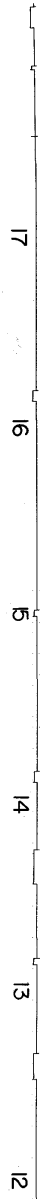
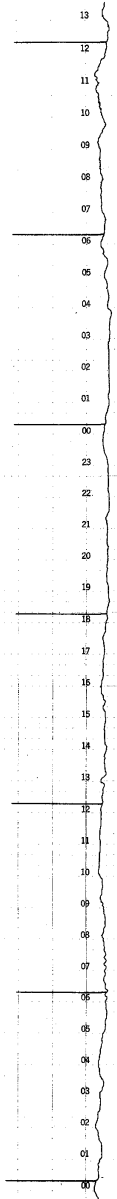


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N-S EARTH CURRENT
COLLEGE

SCALE 1 MV/KM





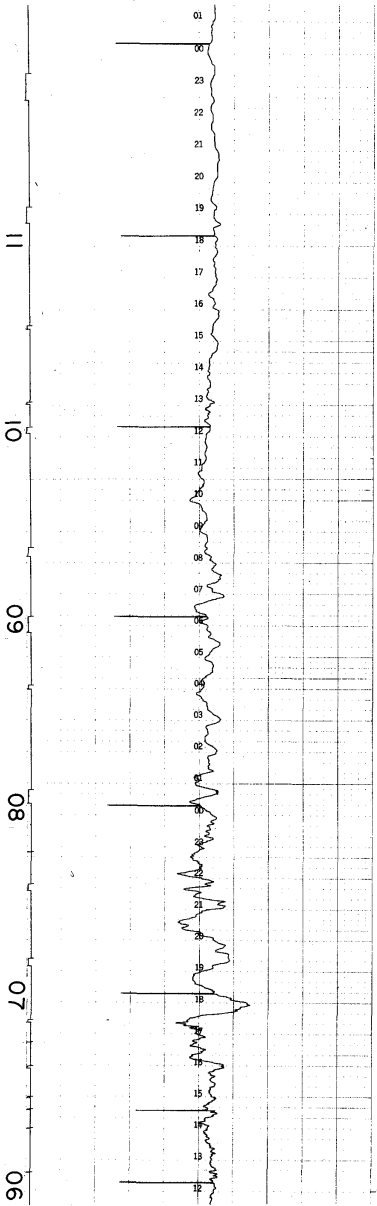
N-S EARTH CURRENT

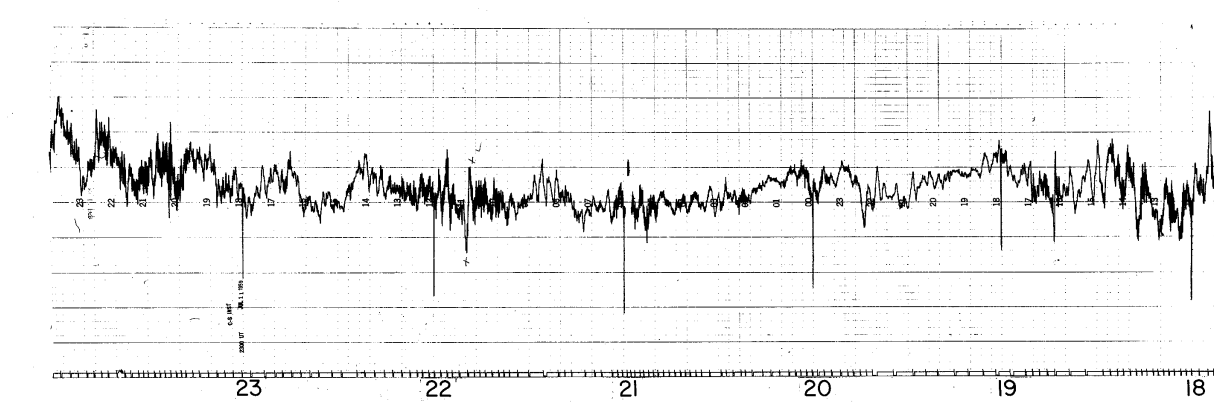
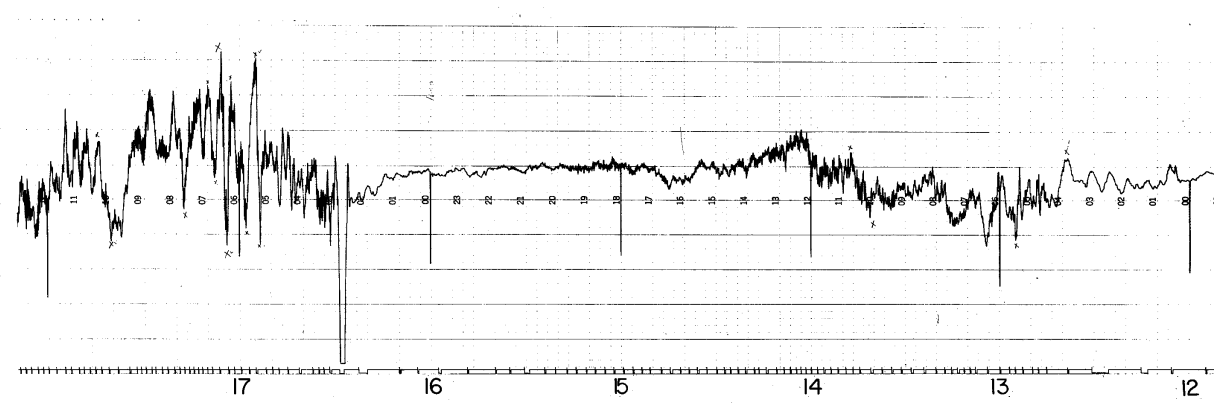
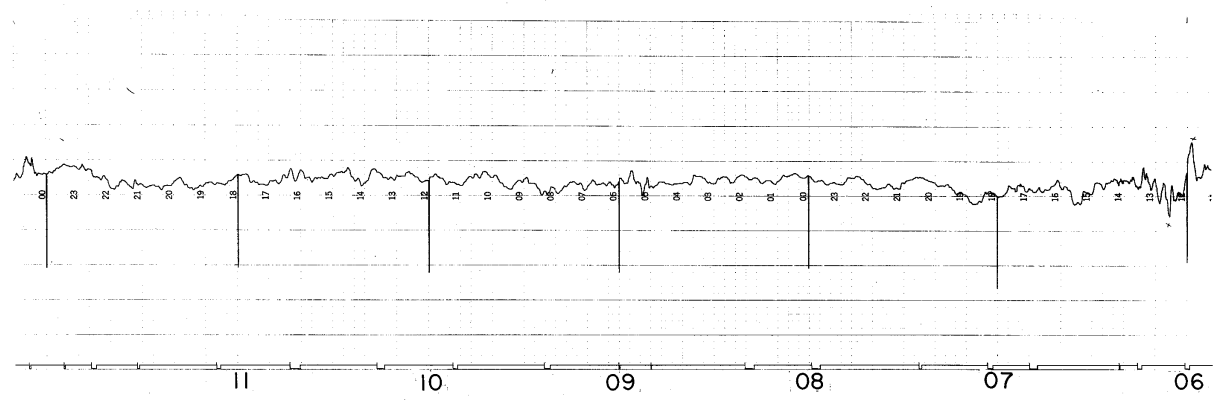
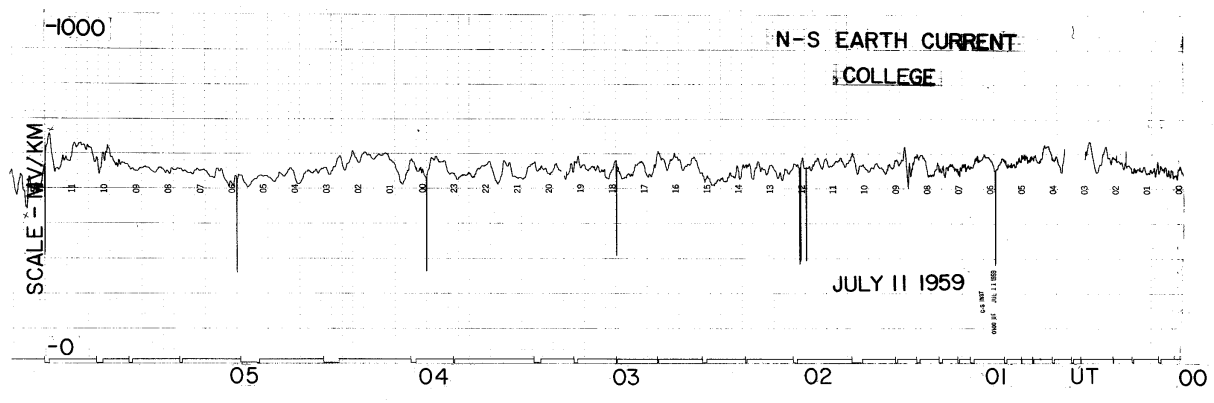
N-S EARTH CURRENT
COLLEGE

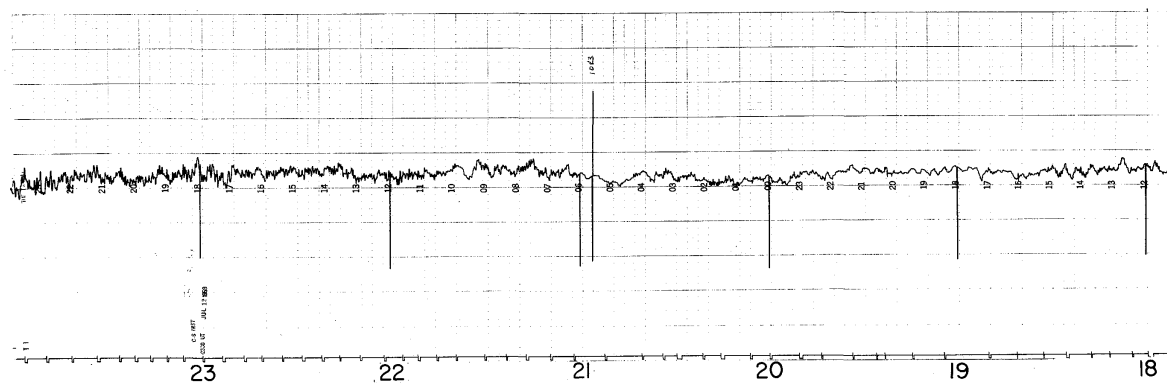
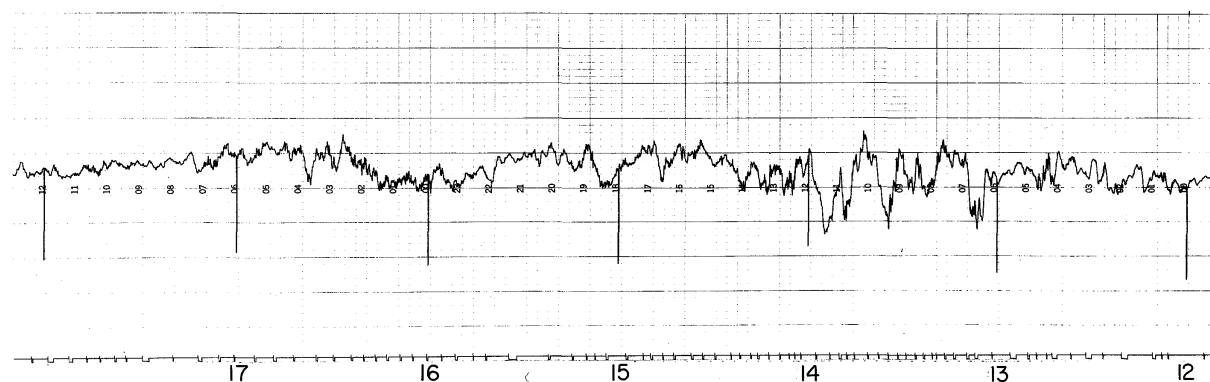
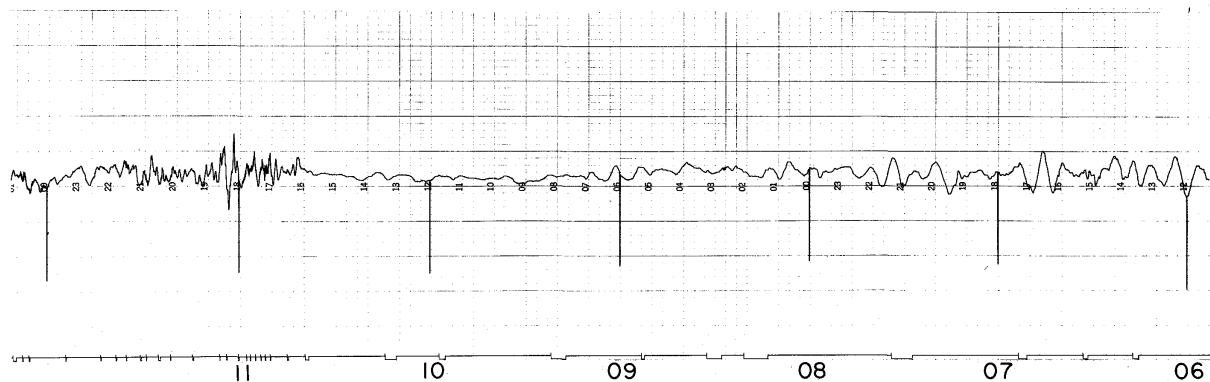
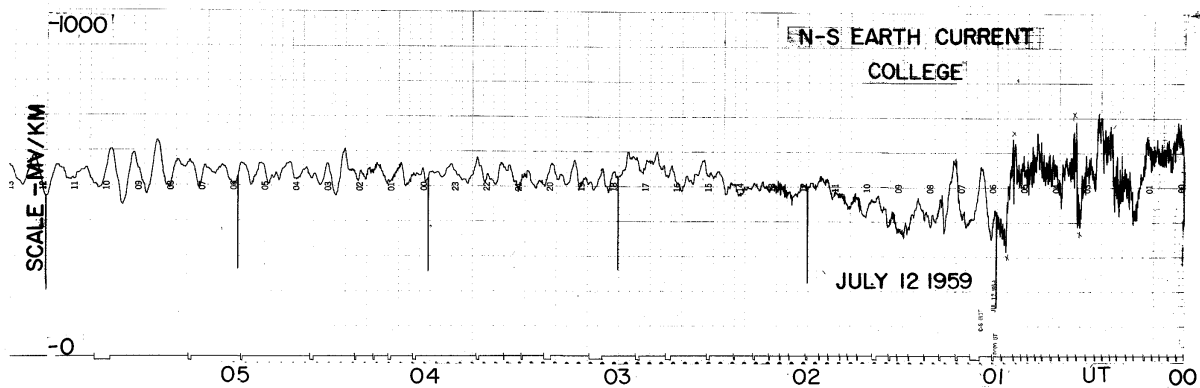
SCALE - $\frac{13}{12}$ MV/KM

JULY 10 1959

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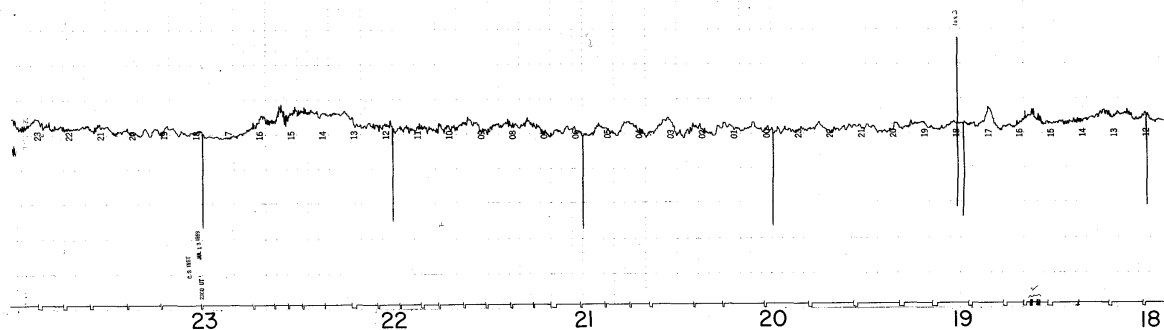
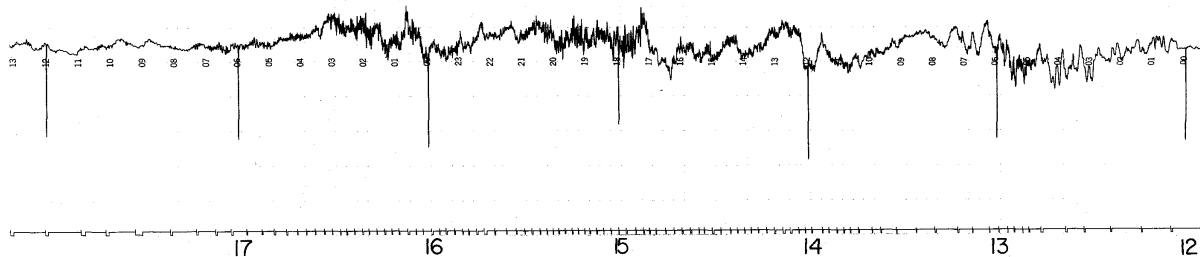
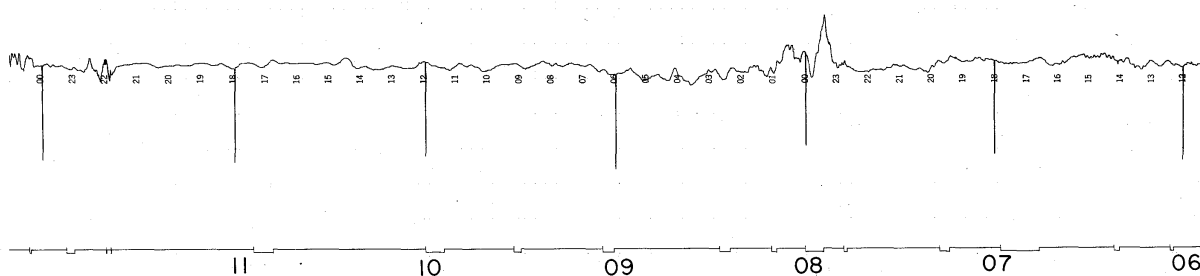
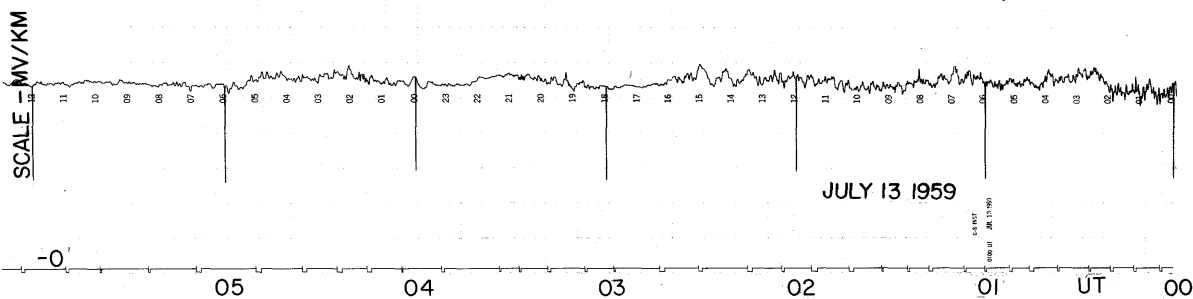


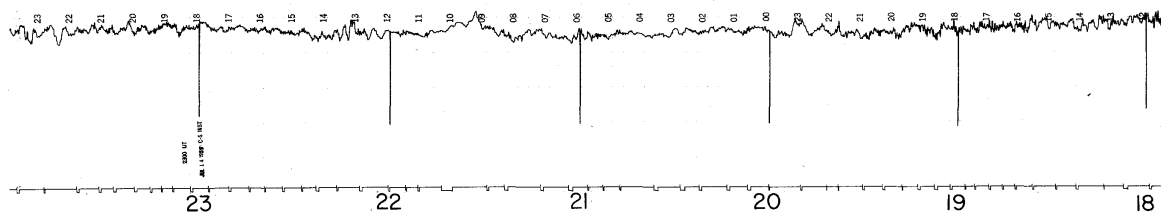
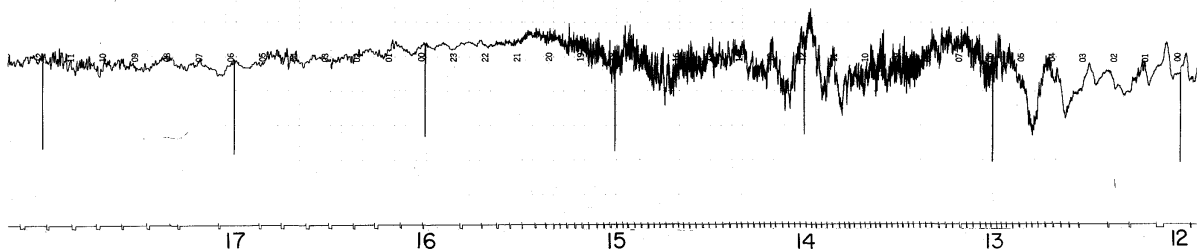
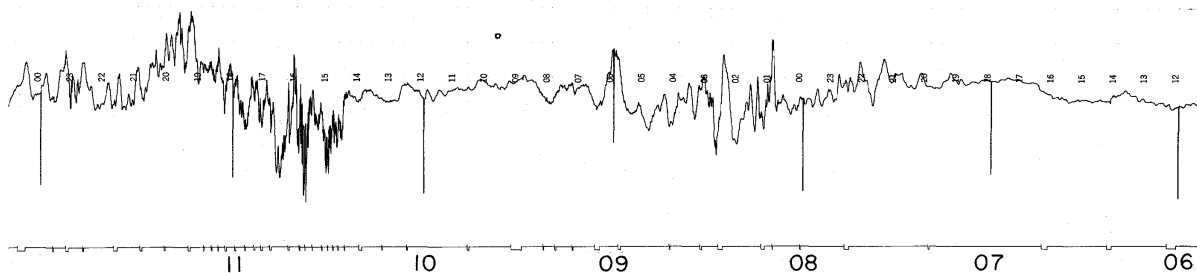
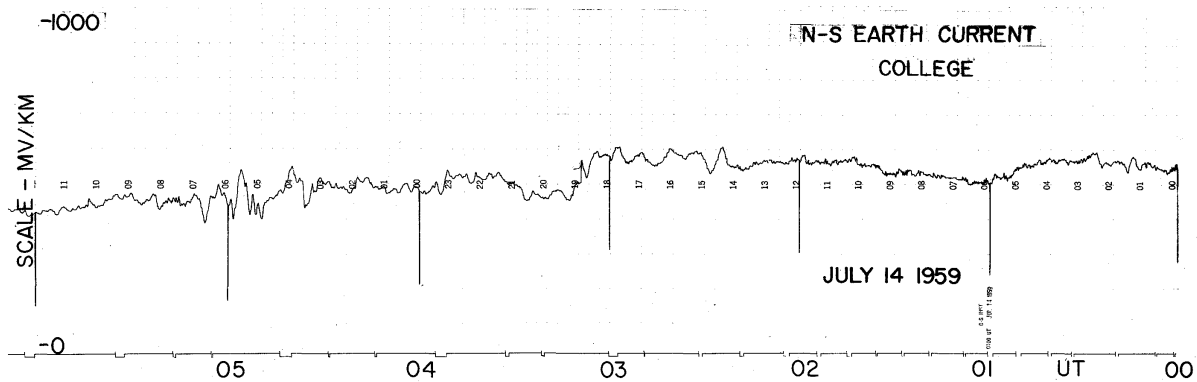


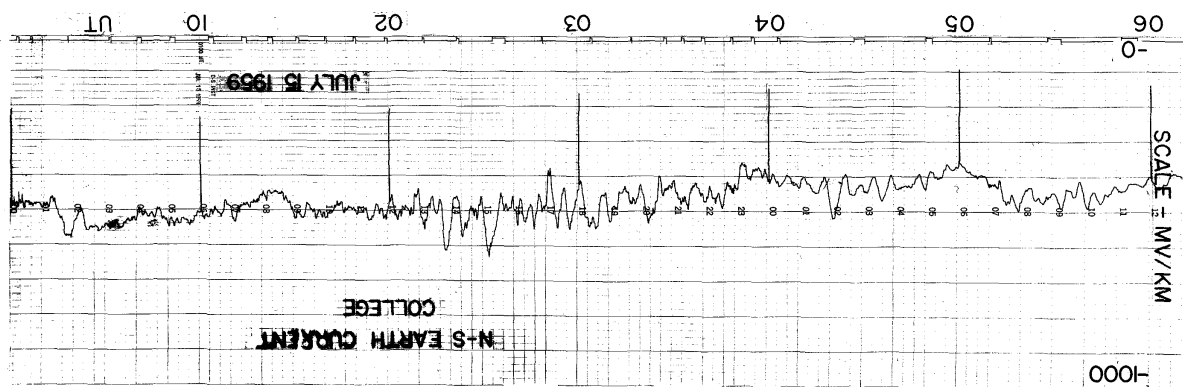
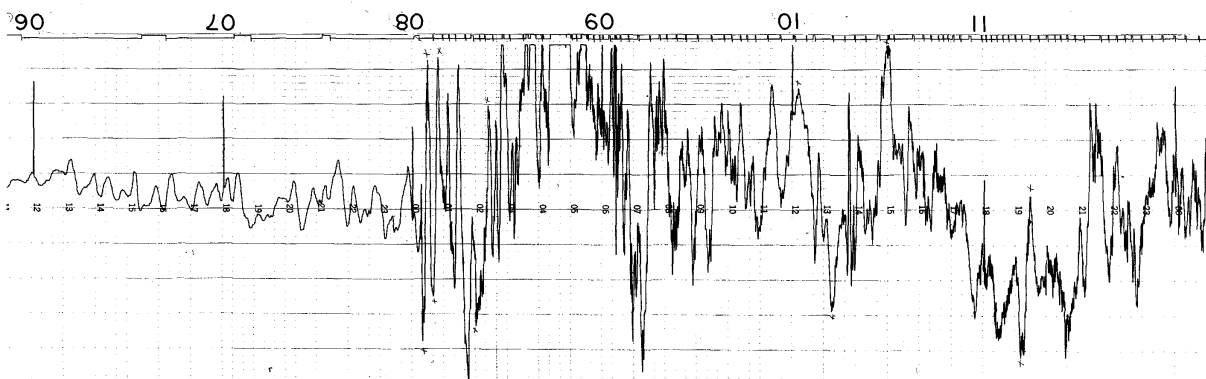
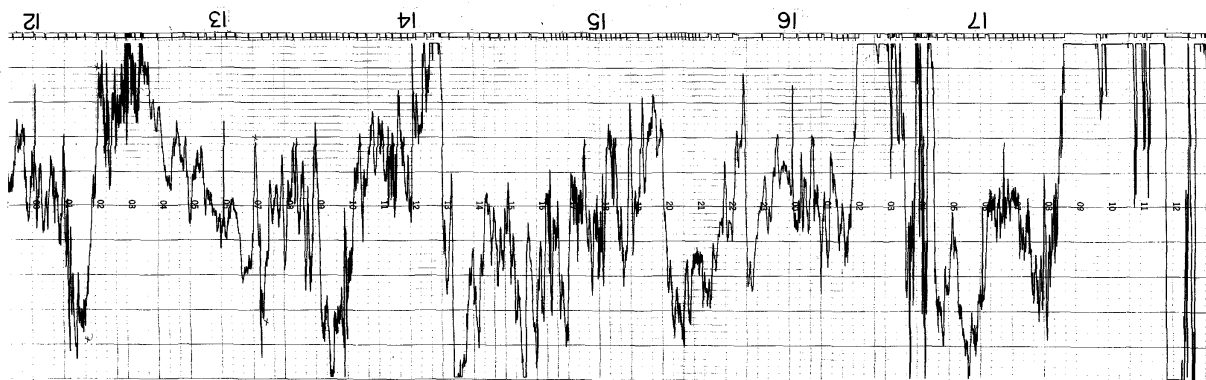
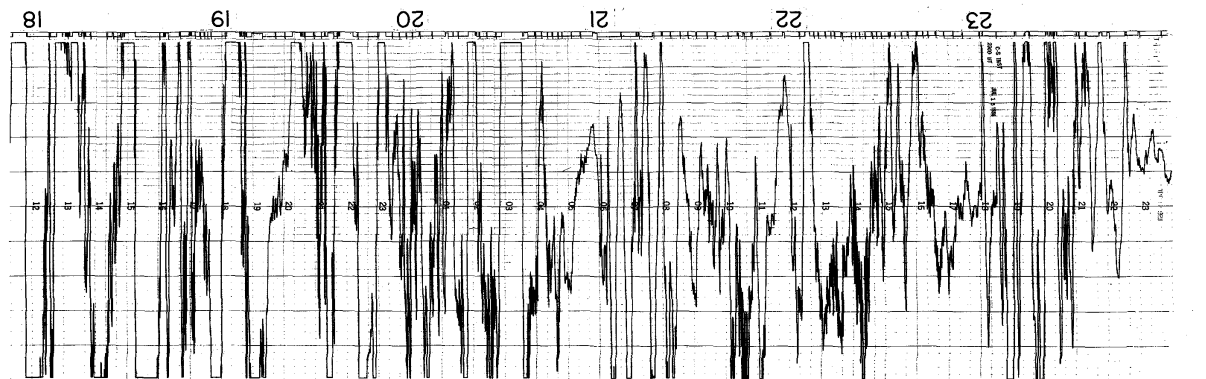


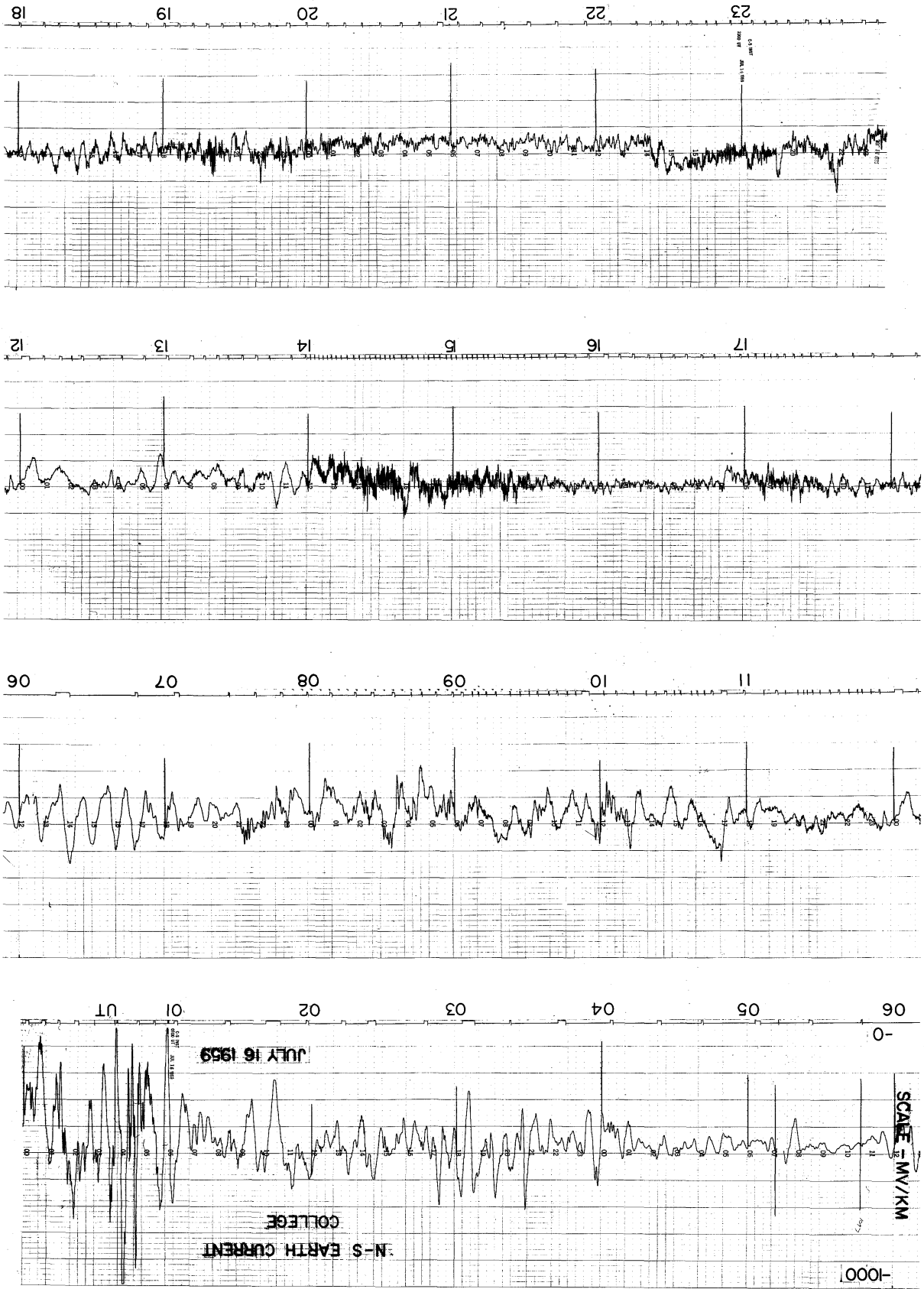
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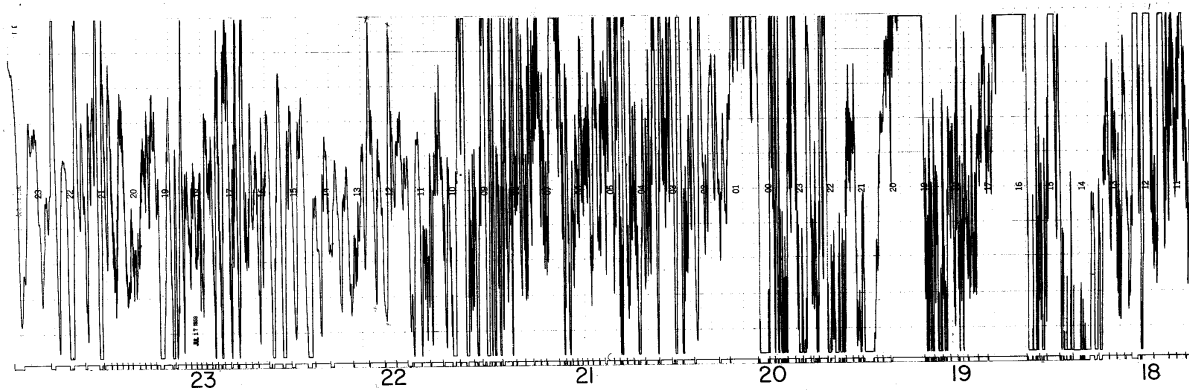
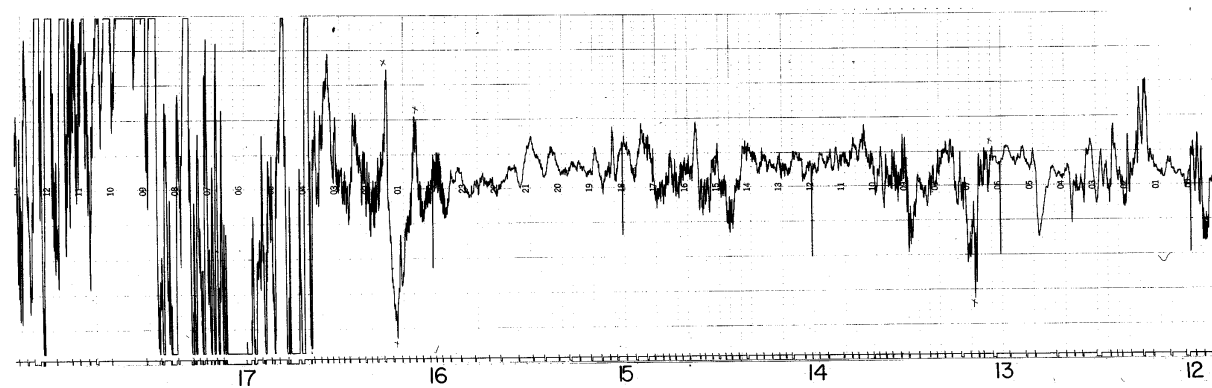
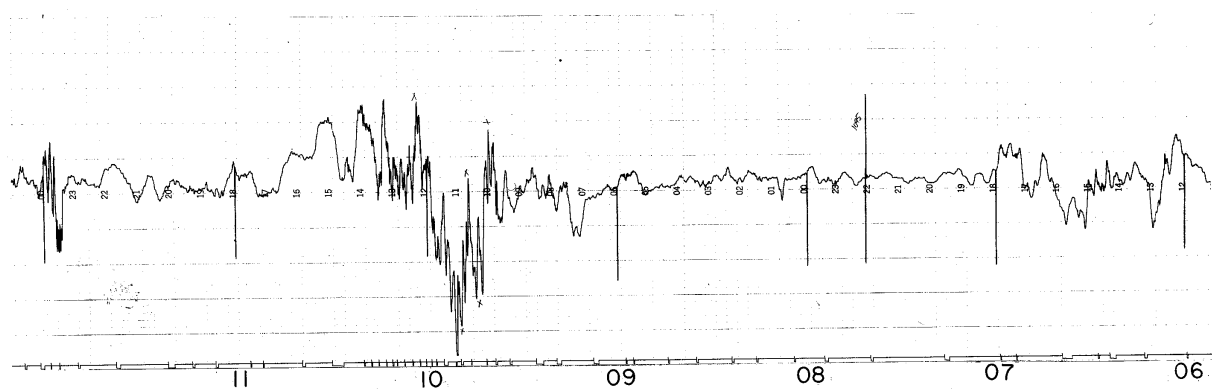
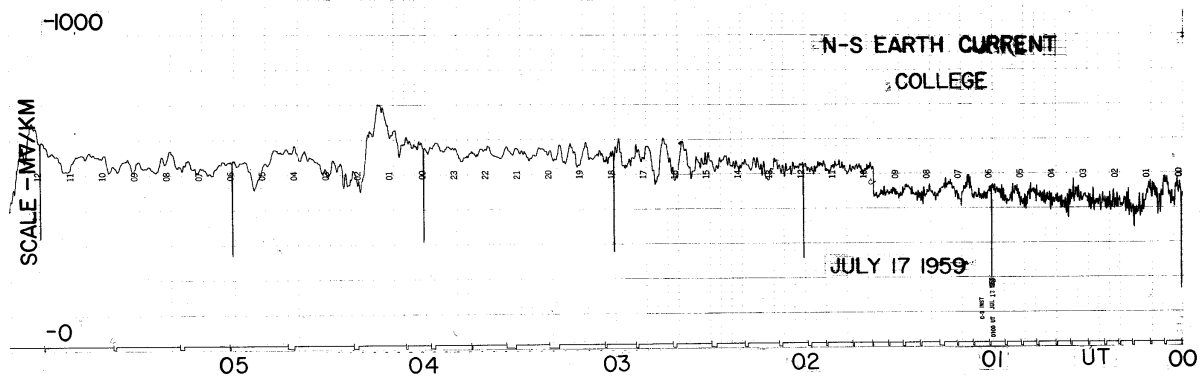
N-S EARTH CURRENT
COLLEGE

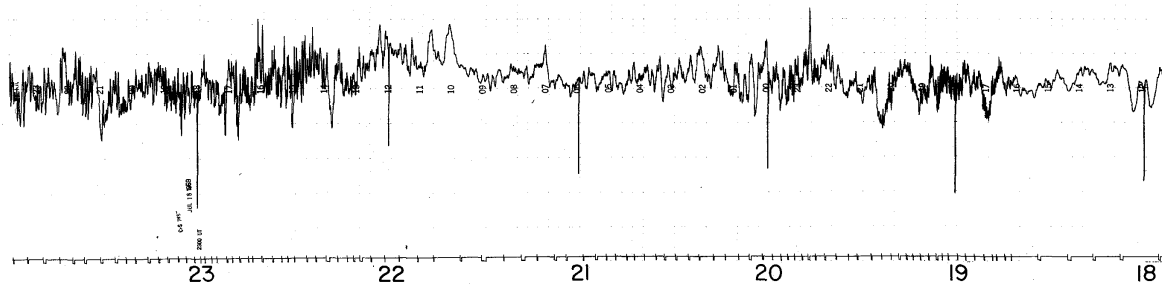
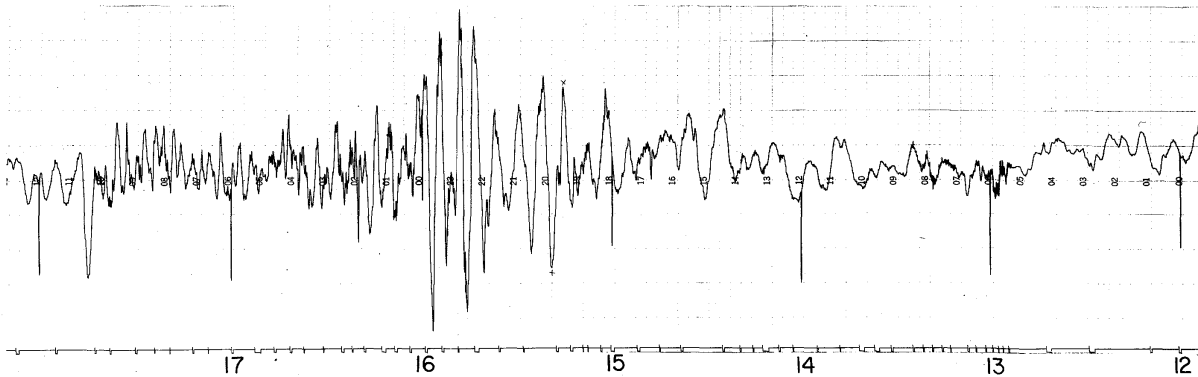
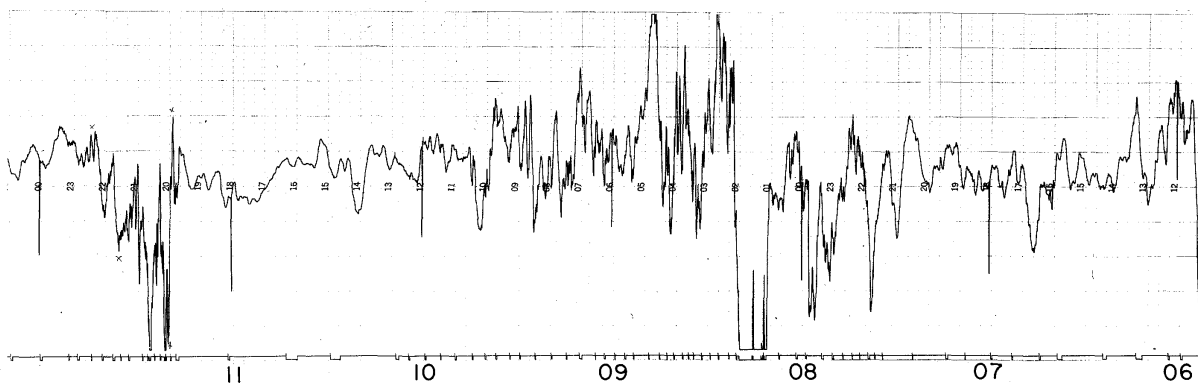
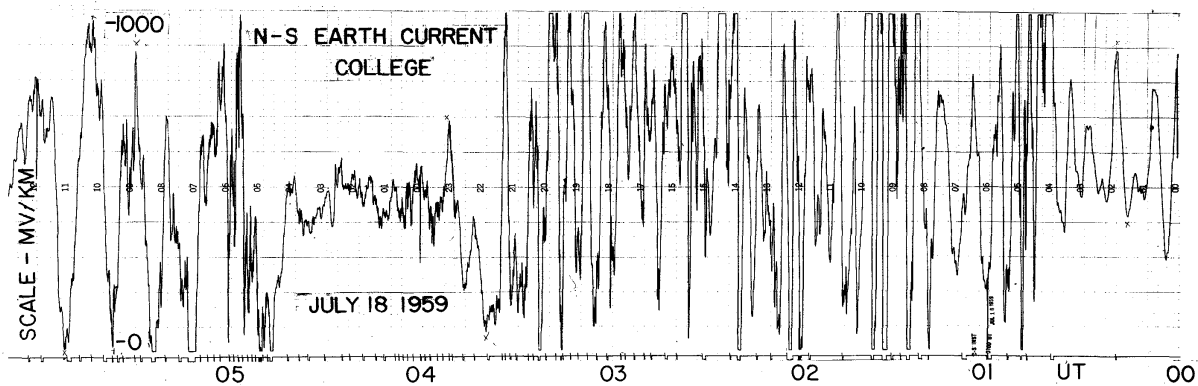


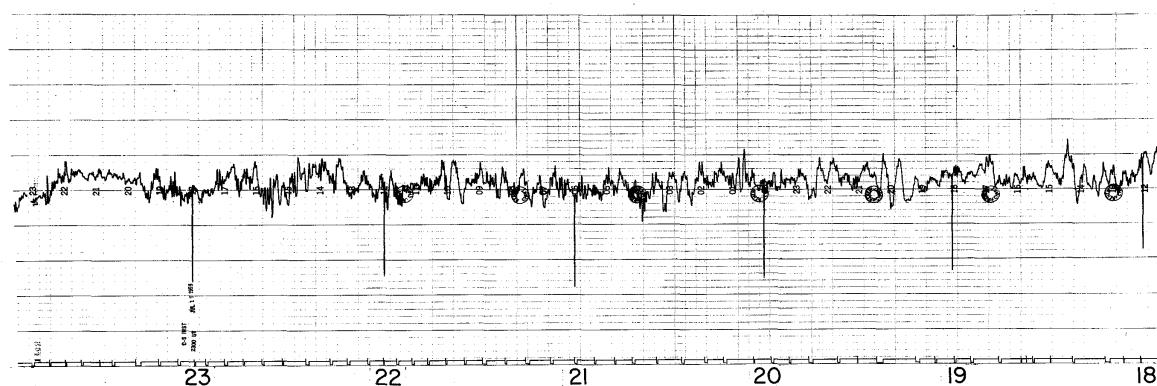
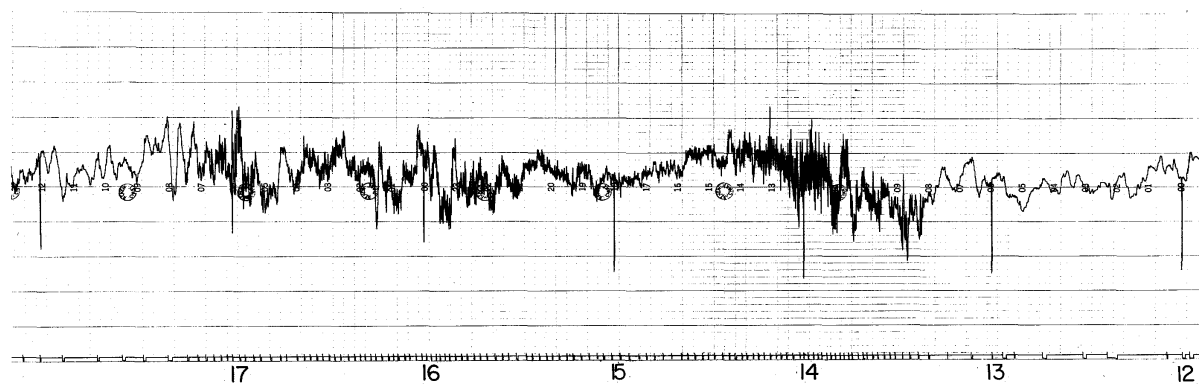
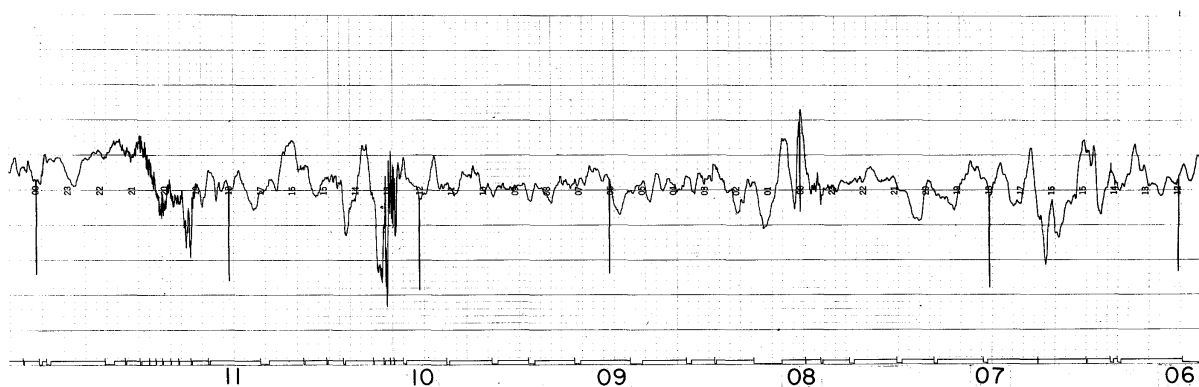
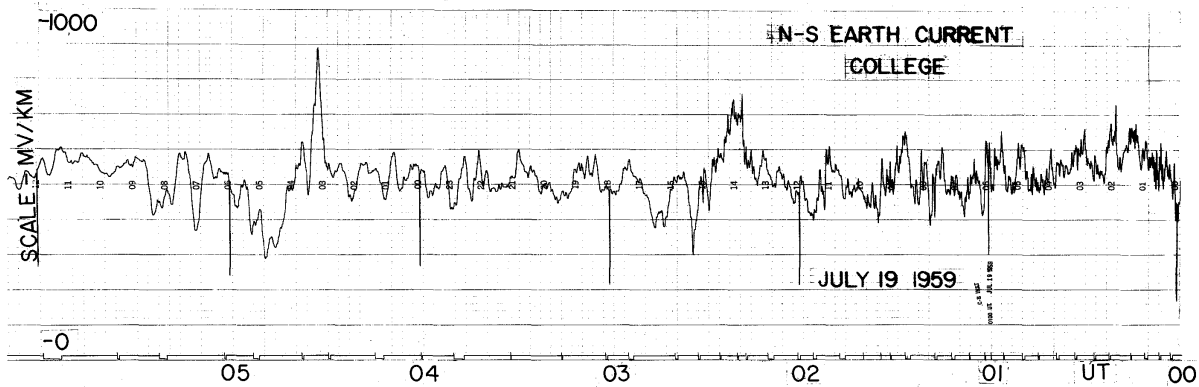


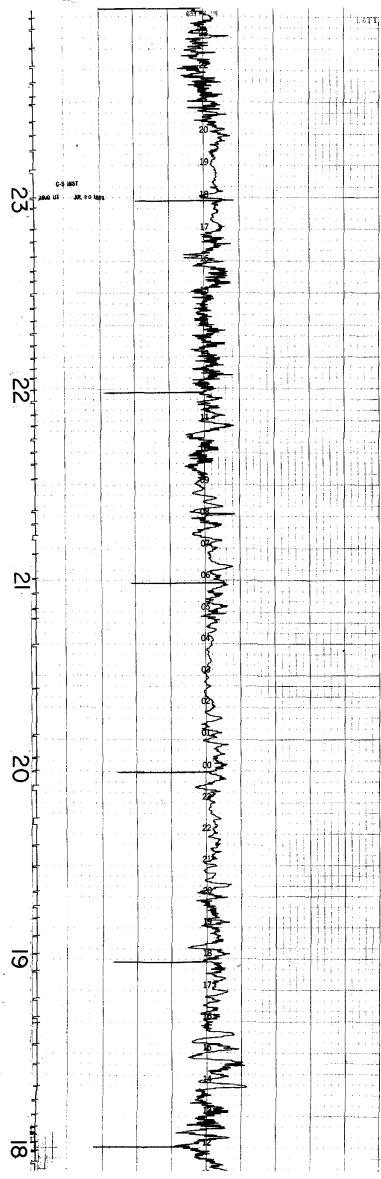
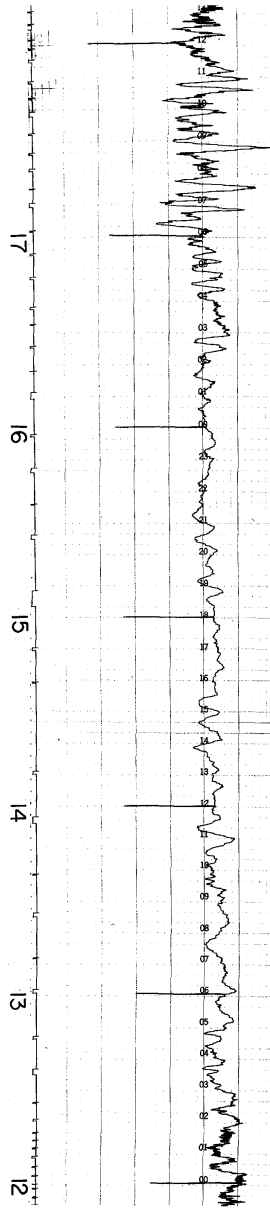










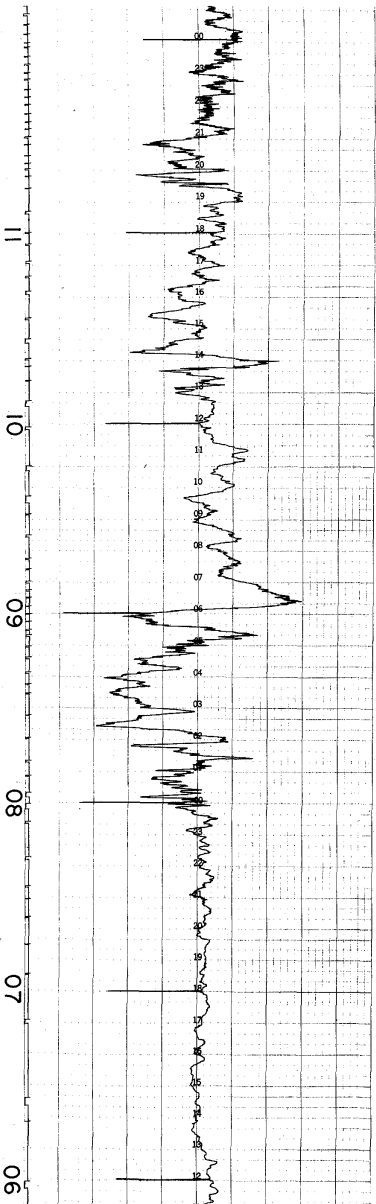
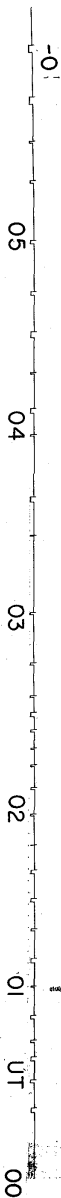


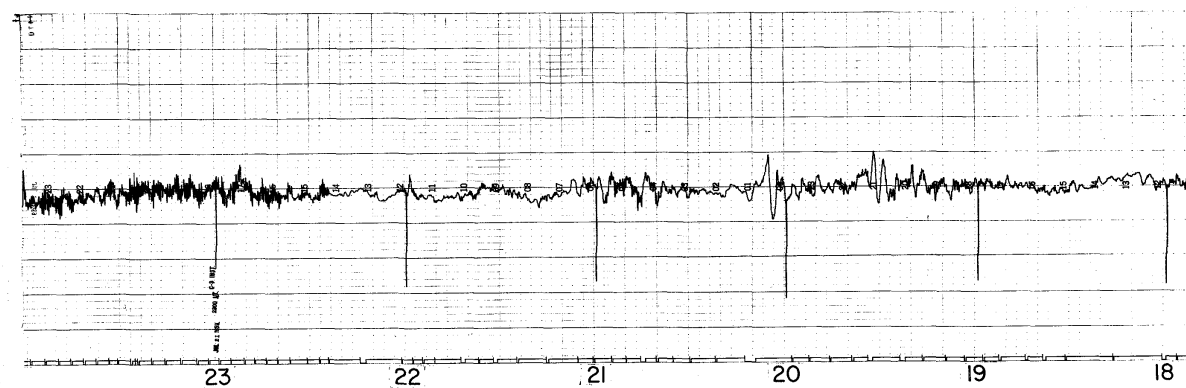
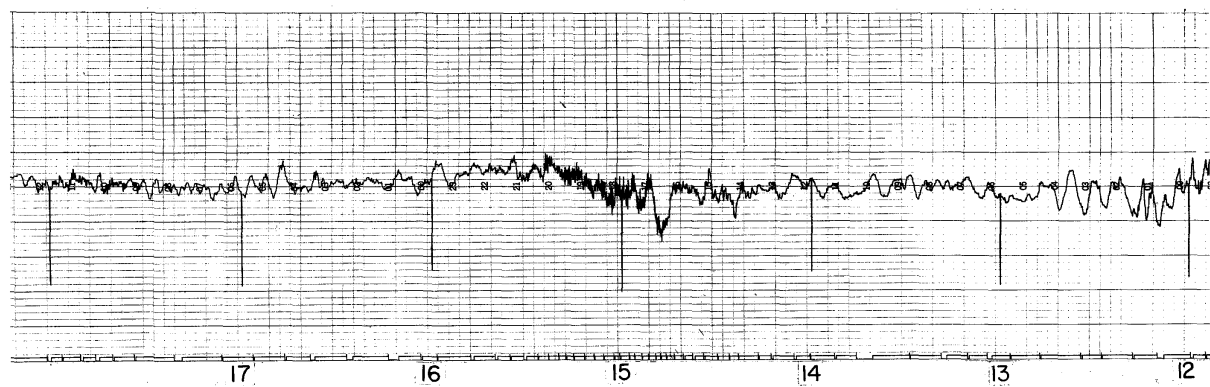
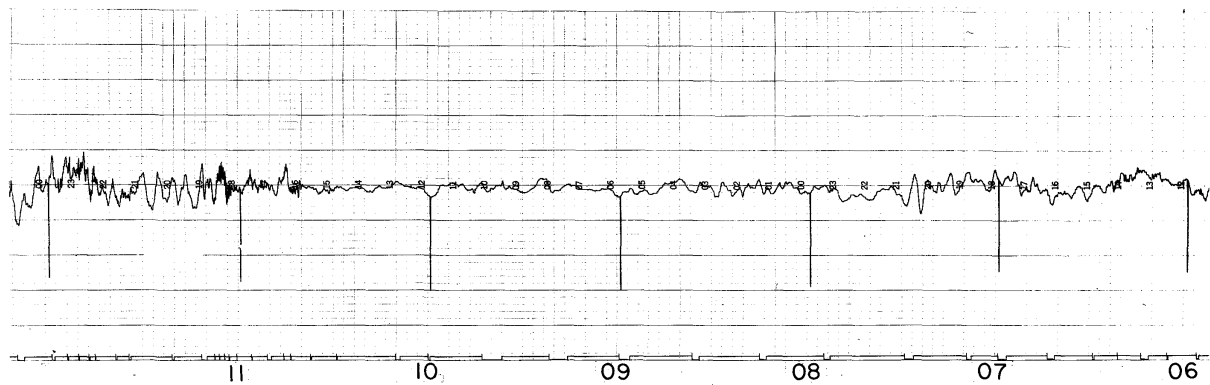
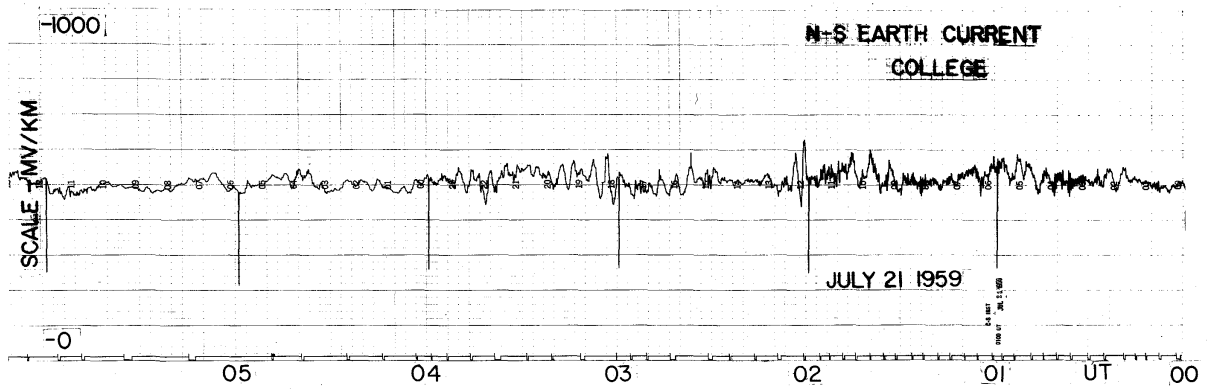
SCALE - MV/KM

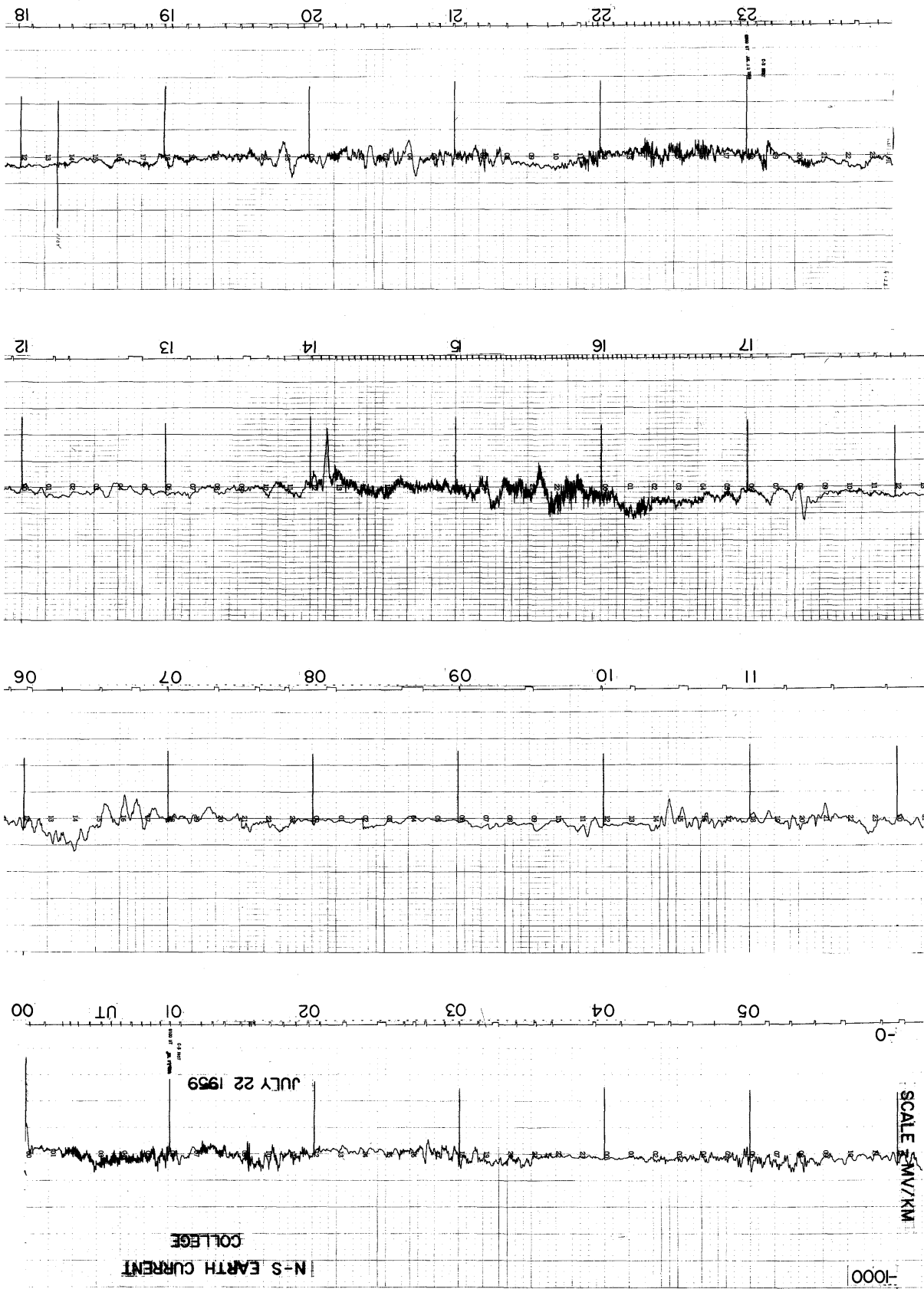
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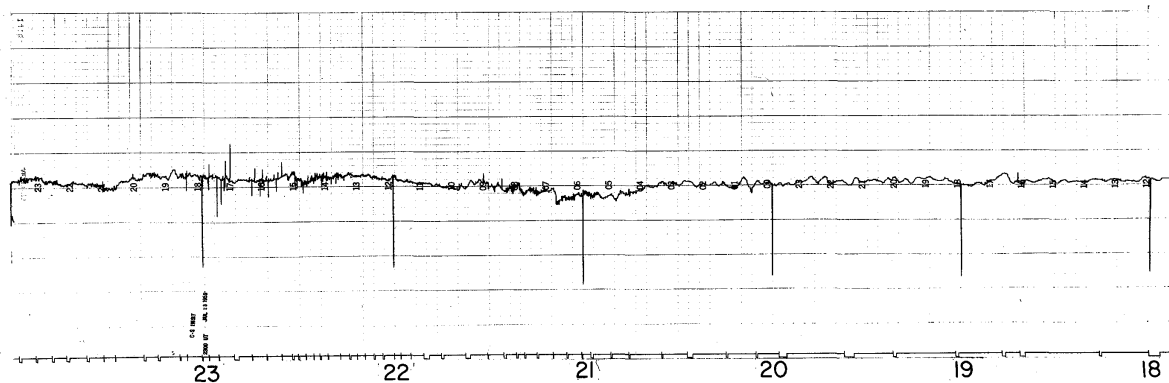
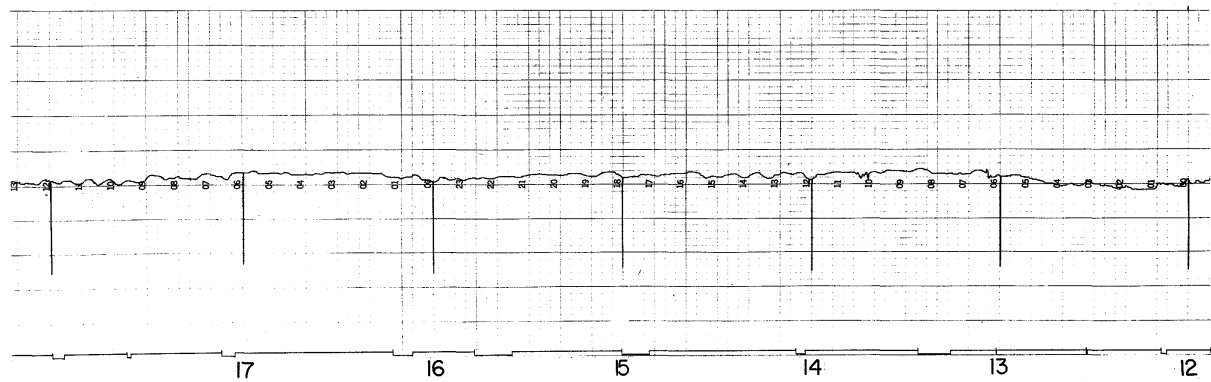
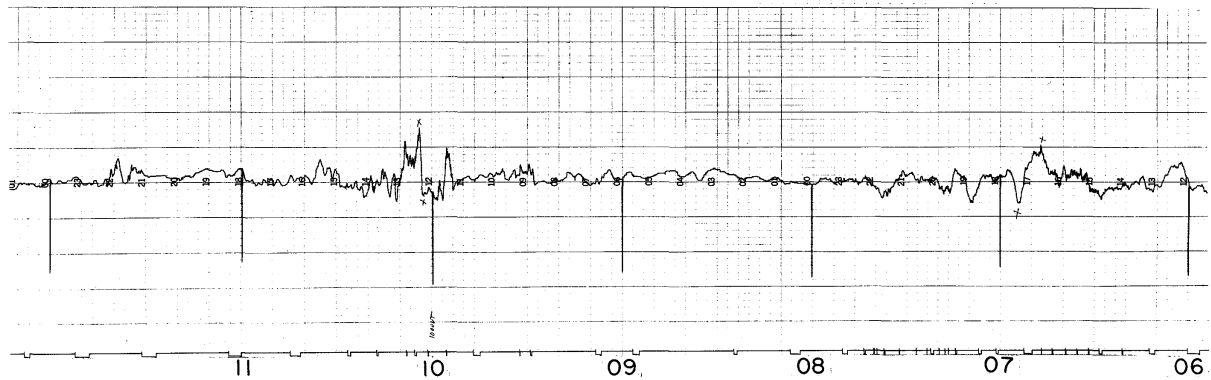
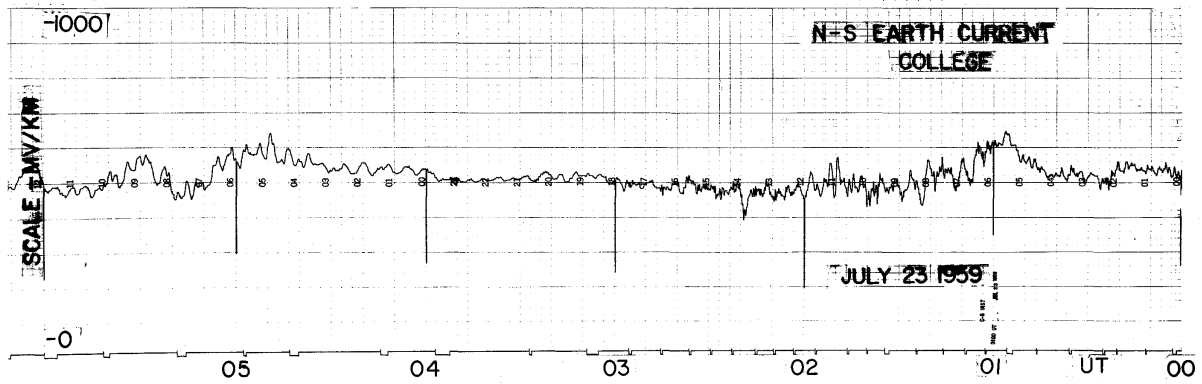
N-S EARTH CURRENT
COLLEGE

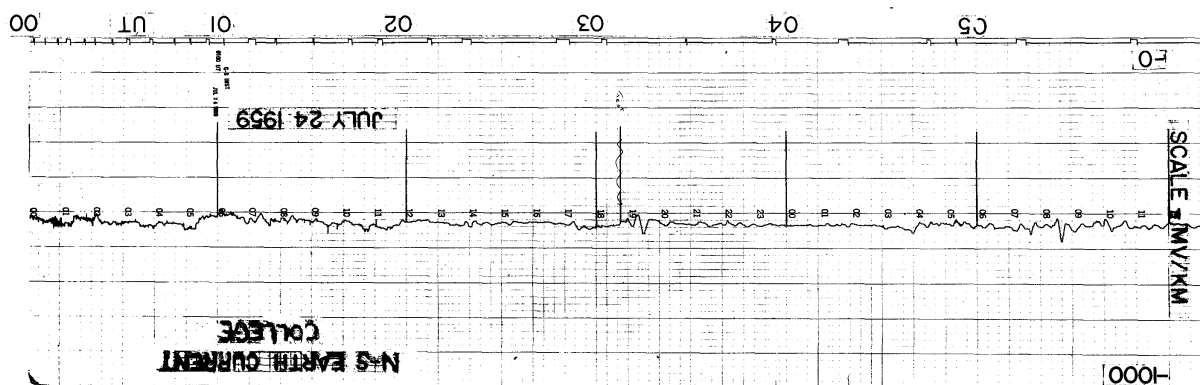
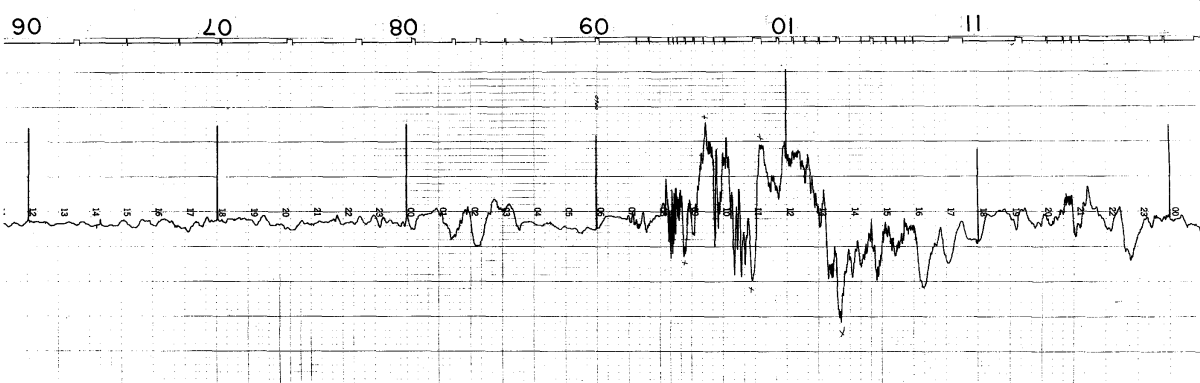
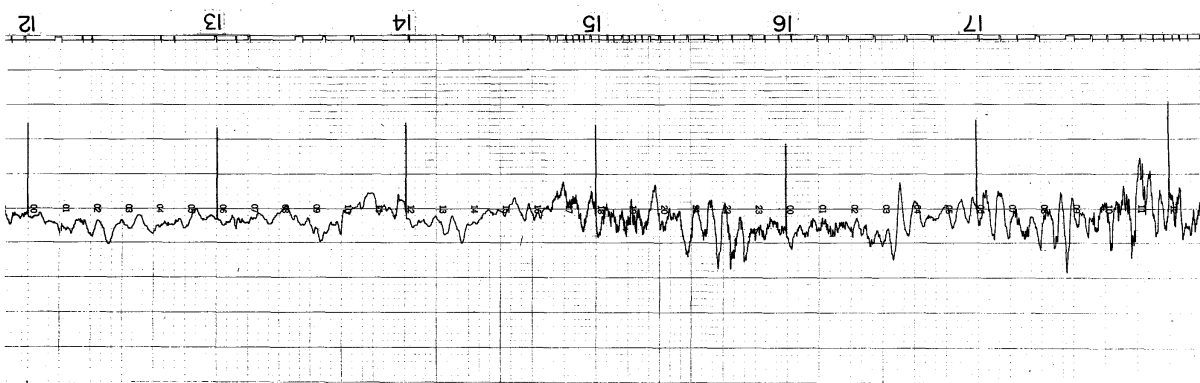
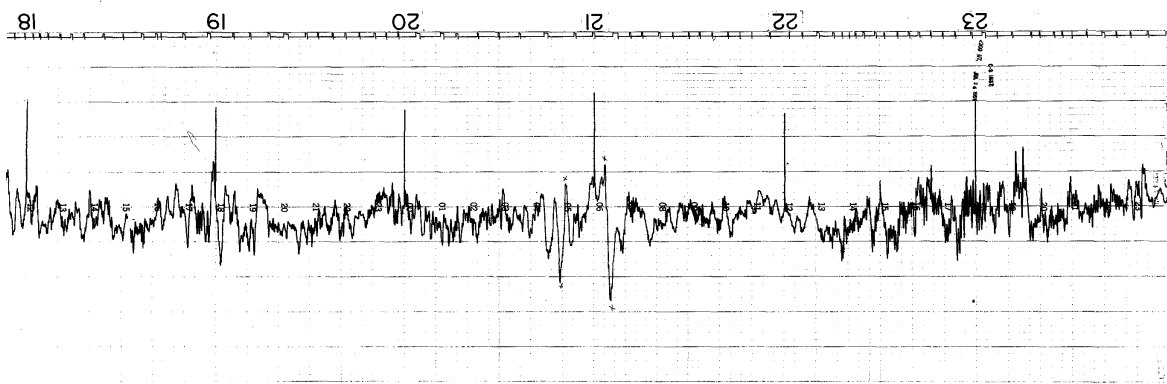
JULY 20 1959









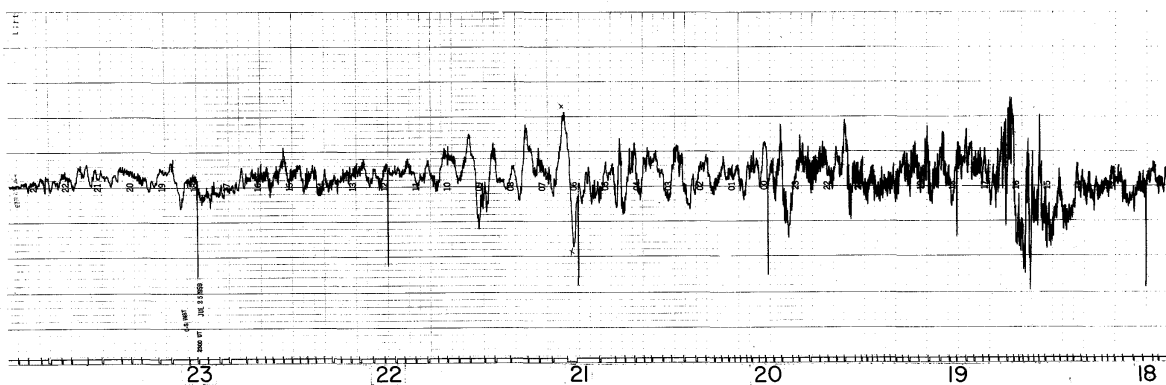
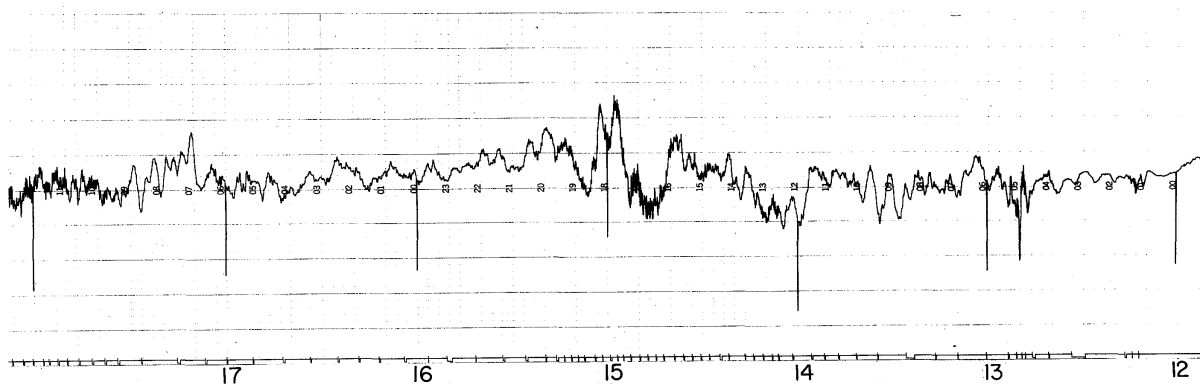
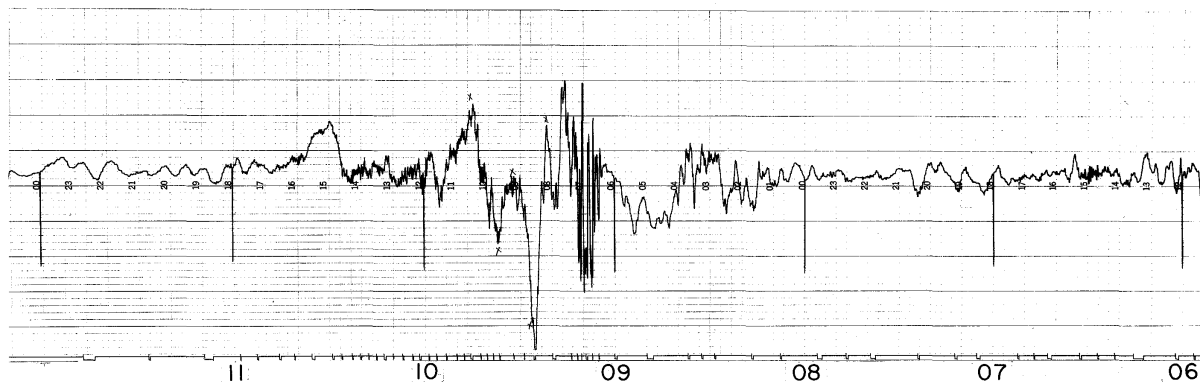
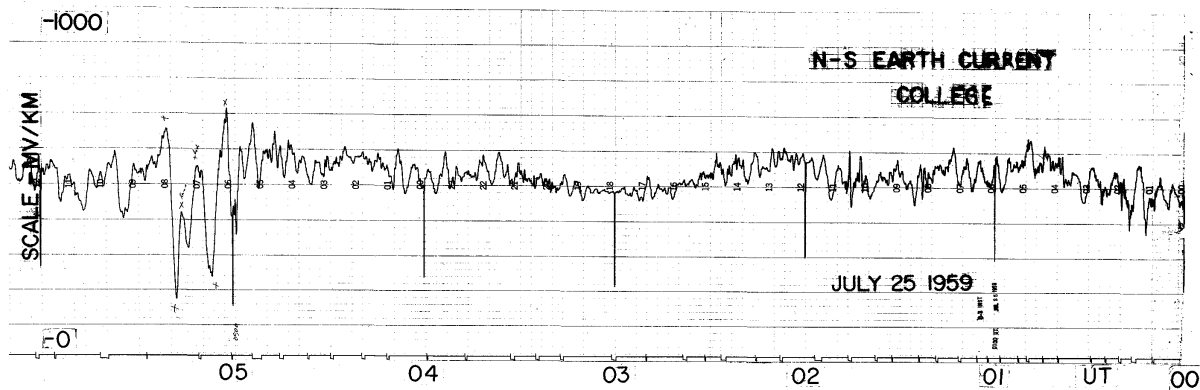


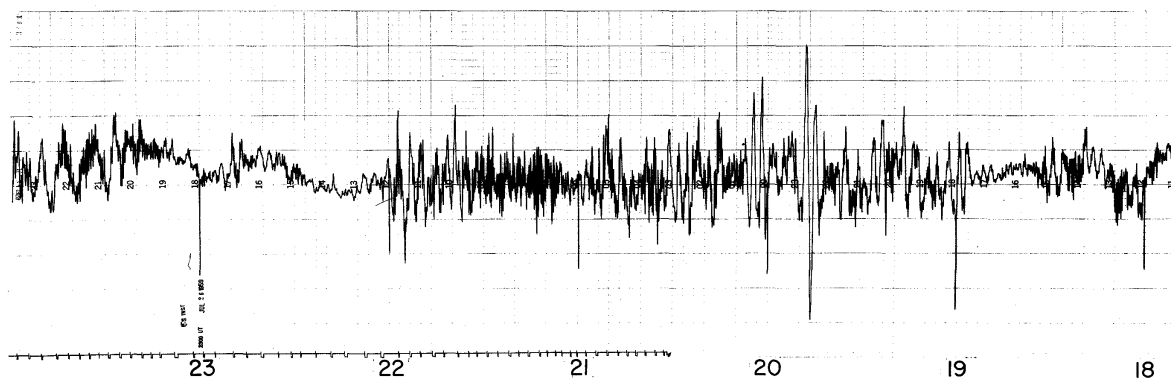
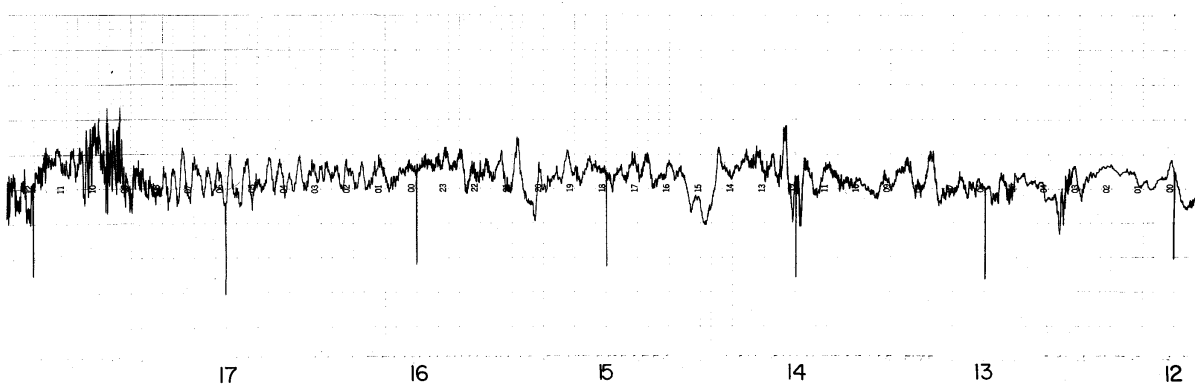
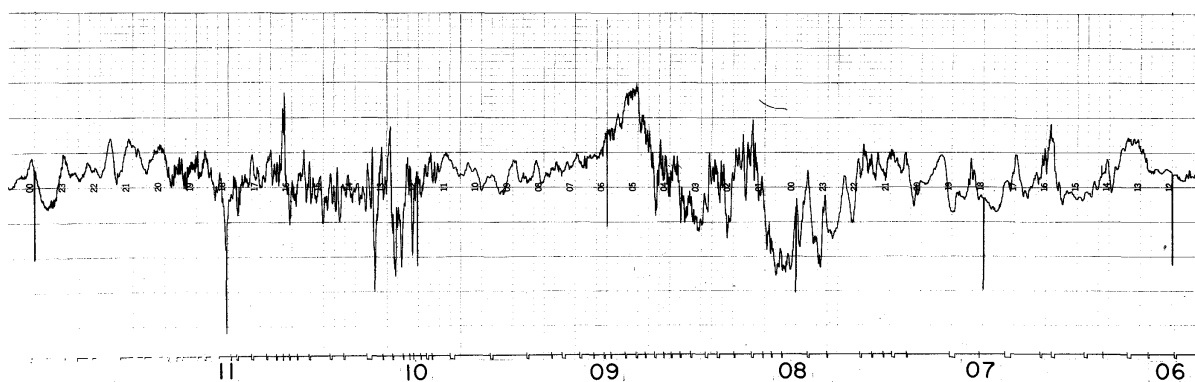
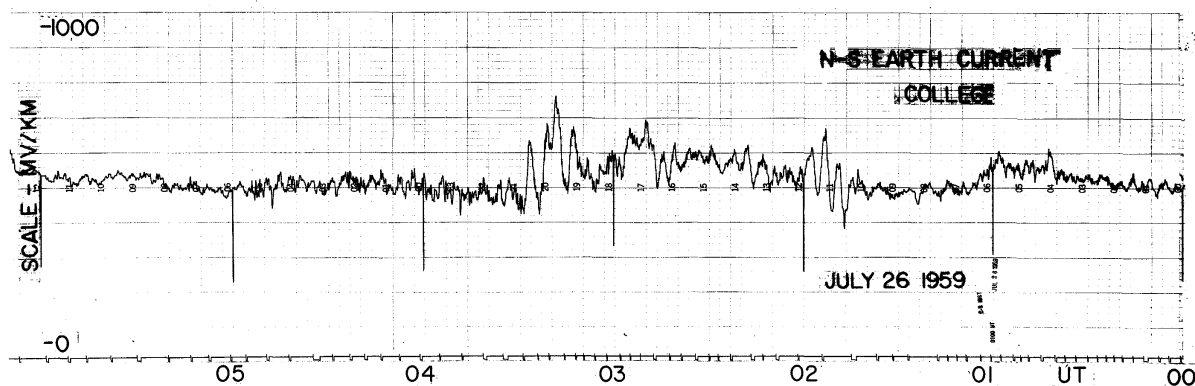
N-S EARTH CURRENT
COLLEGE

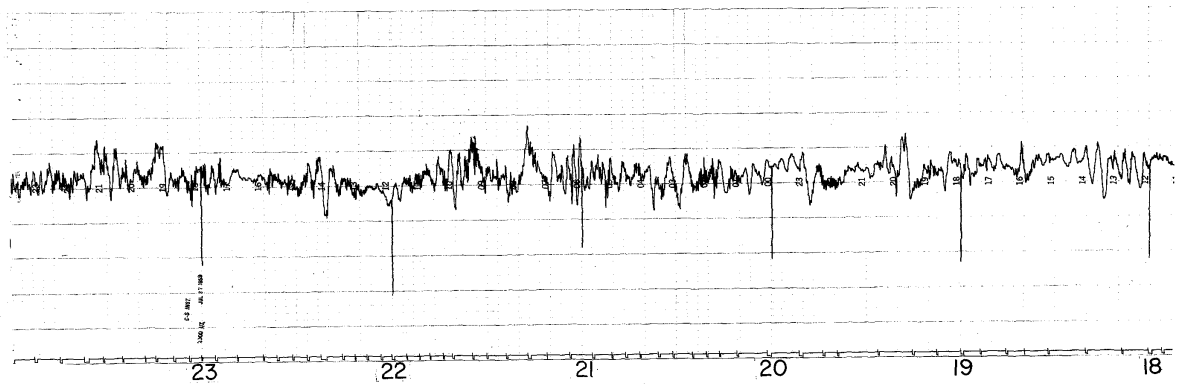
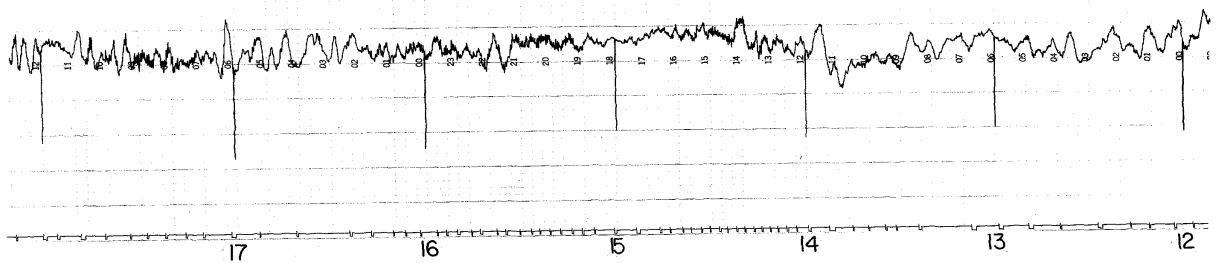
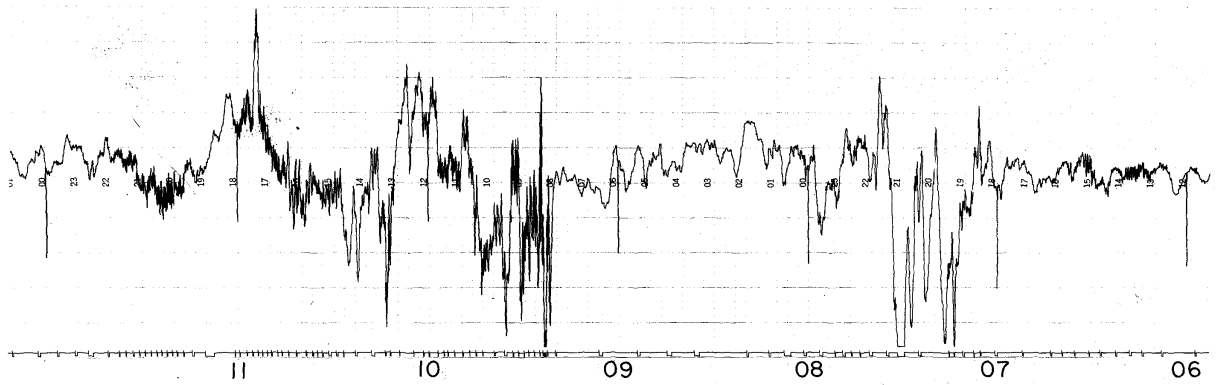
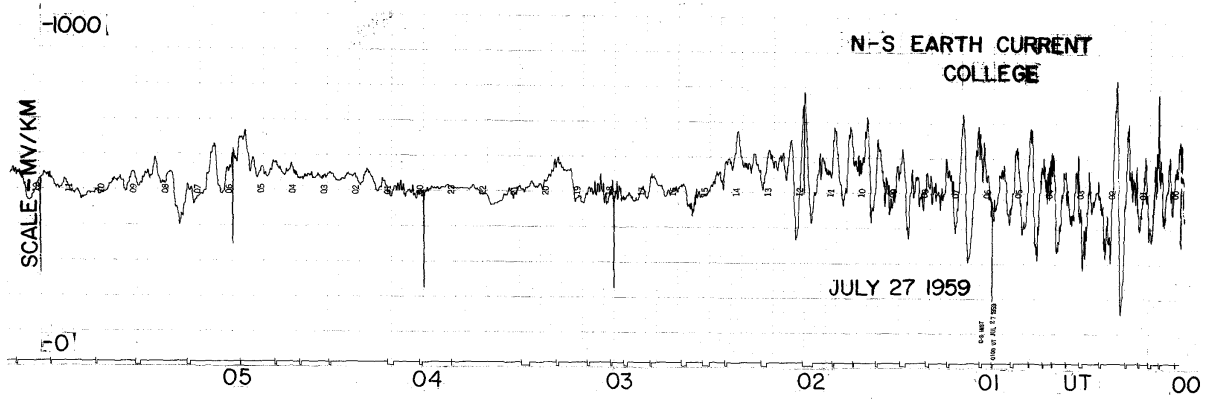
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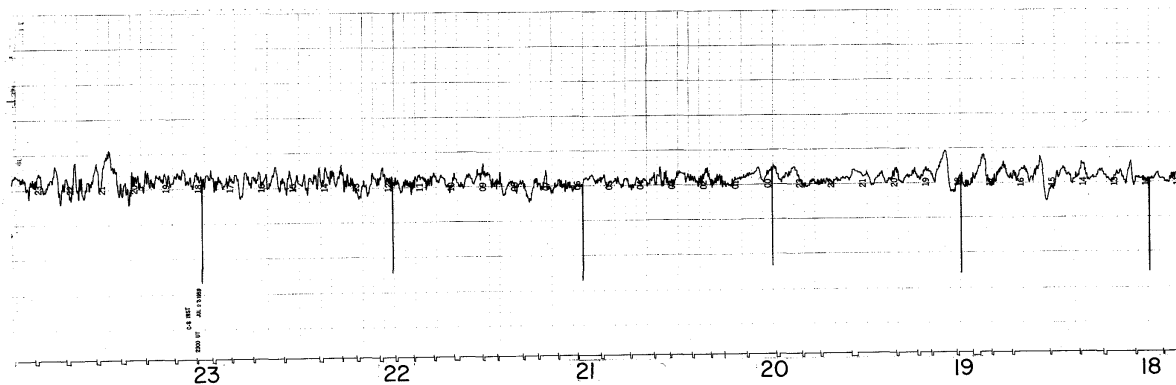
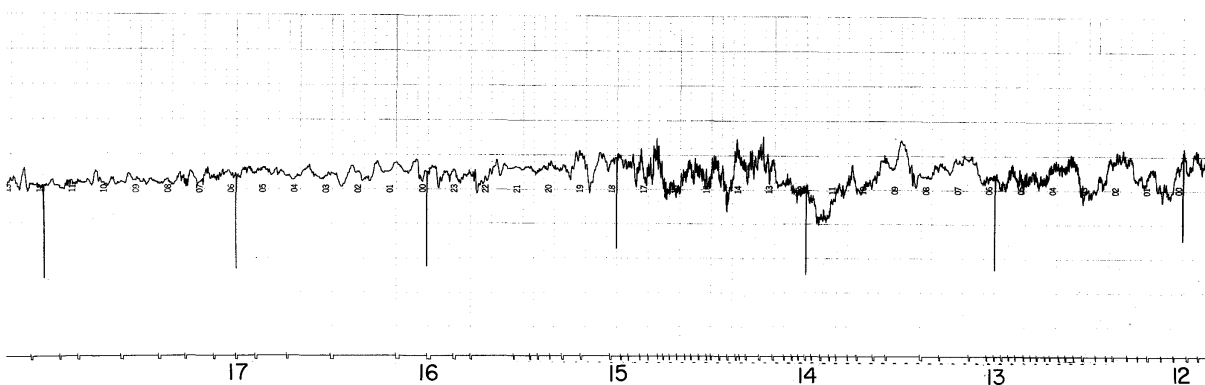
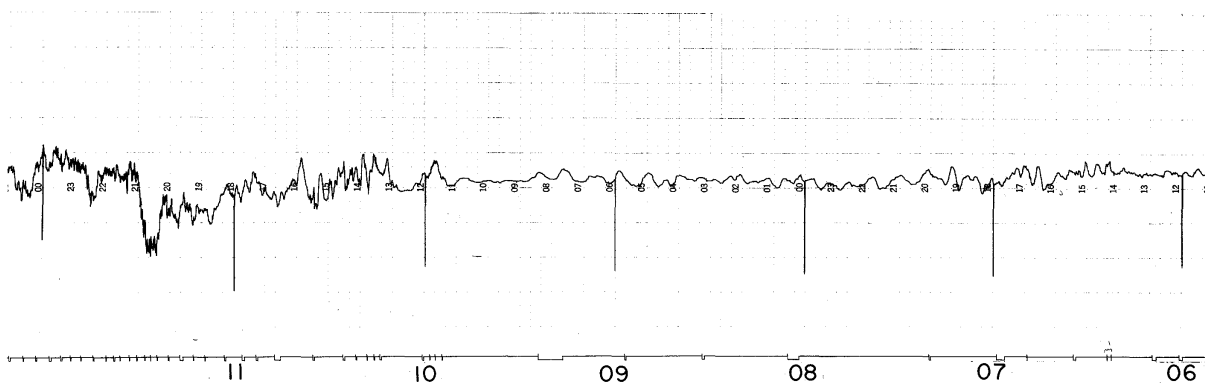
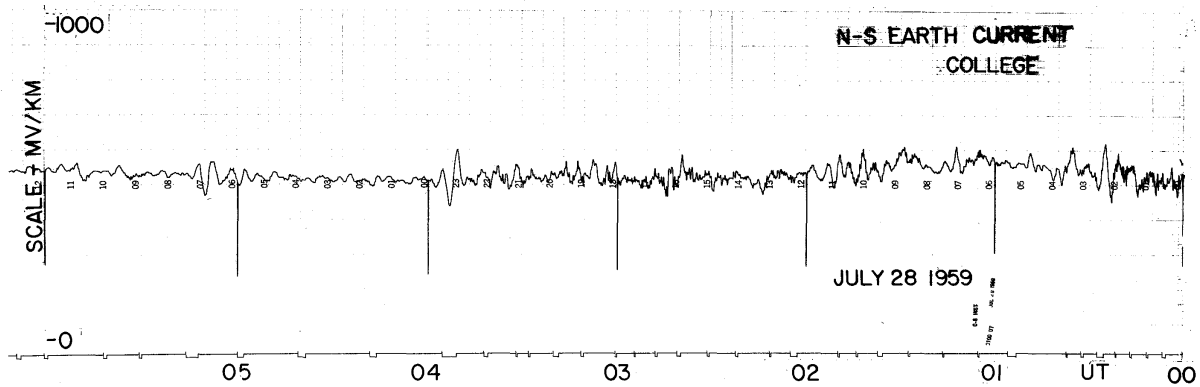
SCALE 1 MV/KM

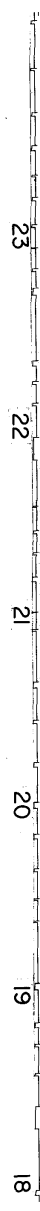
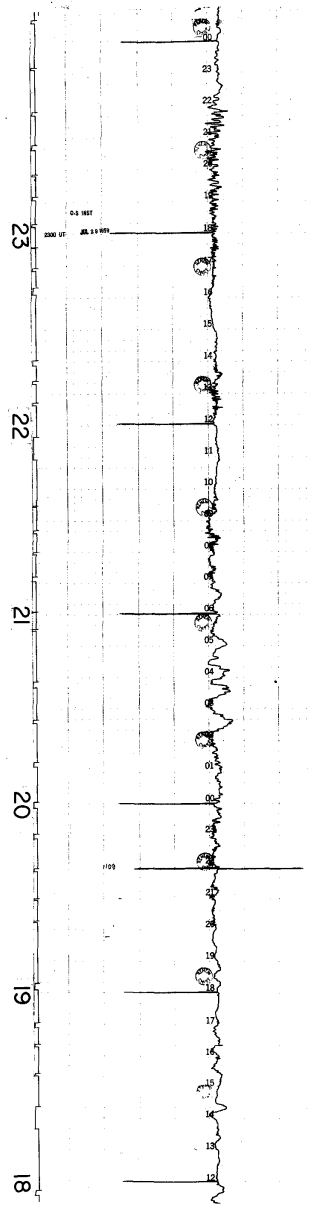
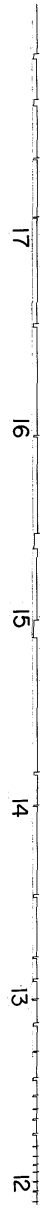
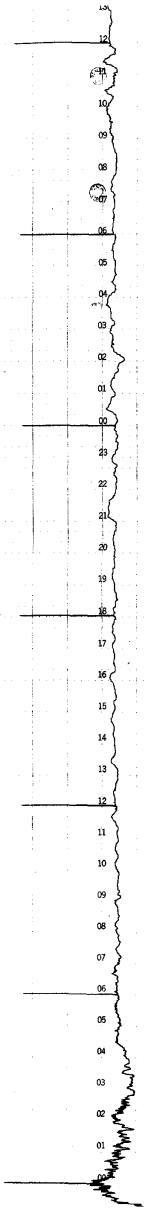
JULY 24 1959







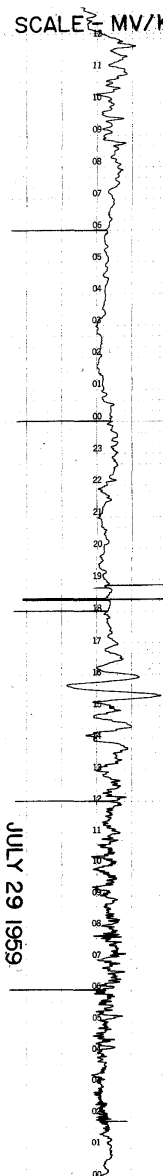




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N-S EARTH CURRENT
COLLEGE

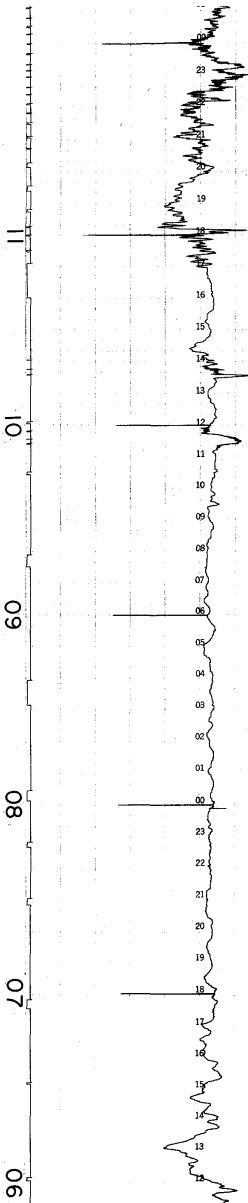
SCALE MV/KM

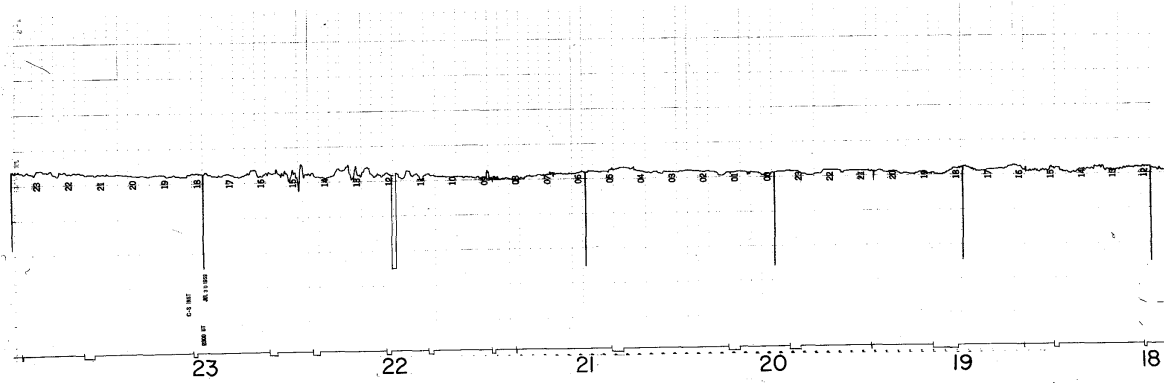
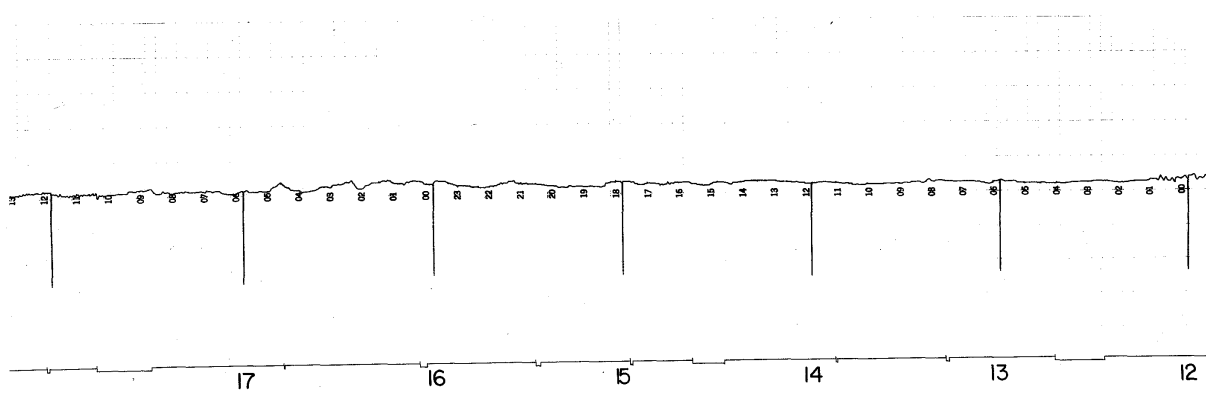
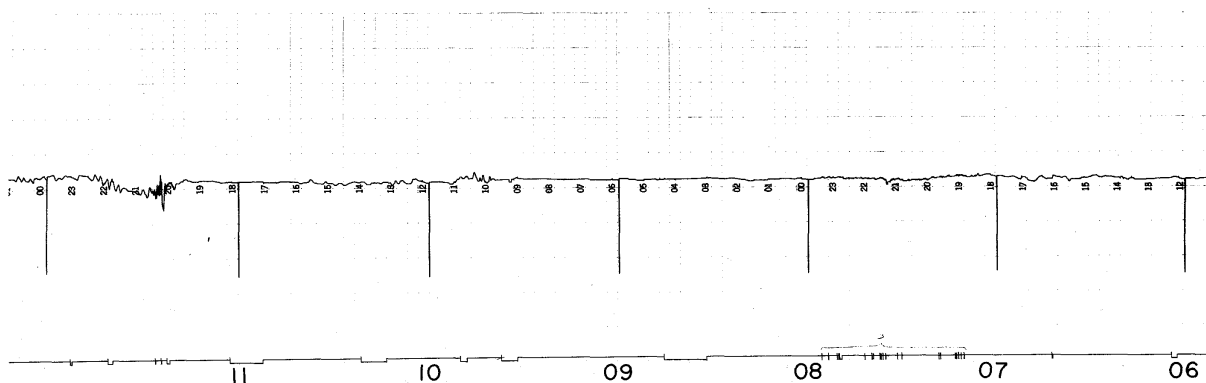
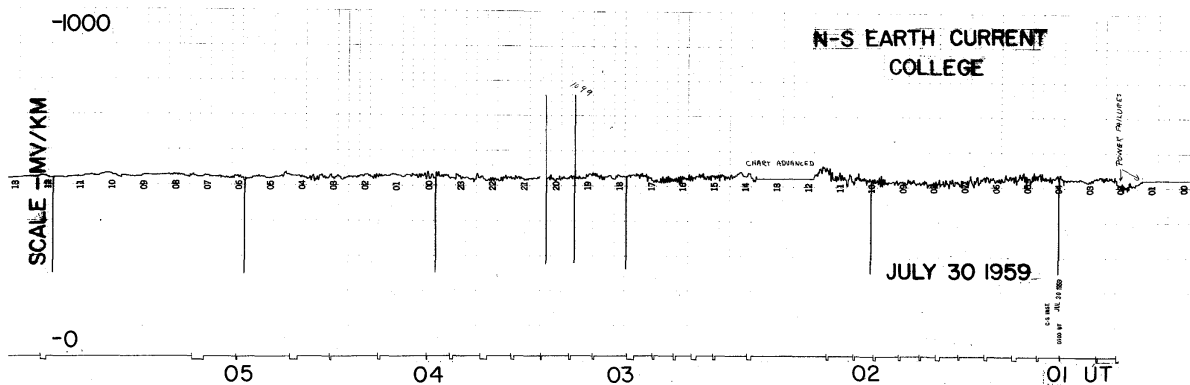


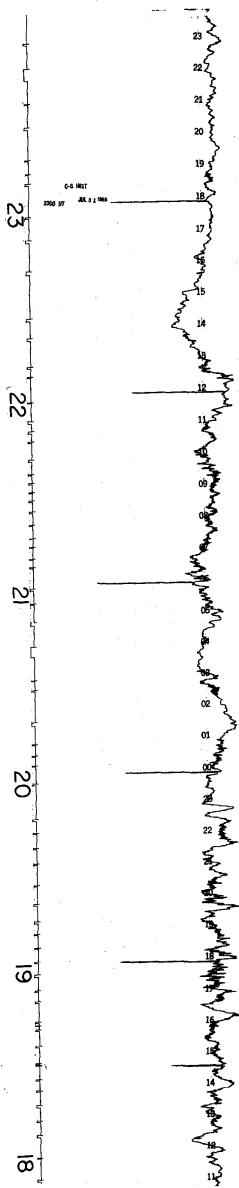
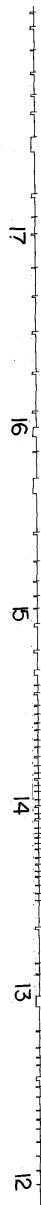
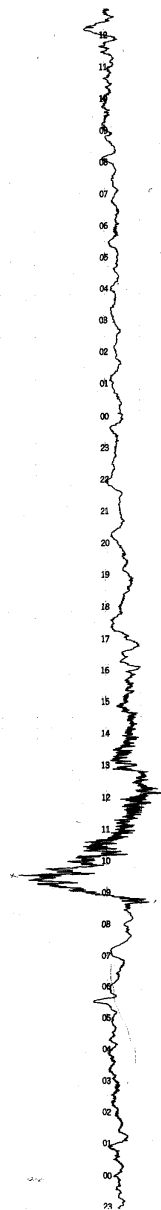
JULY 29 1959

0.5 MV 20 Sec

-0







-1000

N-S EARTH CURRENT
COLLEGE

SCALE 1 MV/KM

JULY 31 1959

0-5 HRS
000-1000 UT

